"Always Already Technological": New Views of Music and the Human in Musicology and the Cognitive Sciences

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ABSTRACT: The relationship between nature and culture has been a traditional battleground for the humanities and the sciences. Now, however, new compatibilities and tensions are emerging between the fields of musicology and music psychology, neuroscience, and cognition, spurred by the incorporation of "technology" into conceptions of "the human." This essay aims to surface and compare changing assumptions about technology in relation to music and the human across these fields. It surveys musicological attention to technology and how this attention has segued into posthumanist paradigms, and it charts the rise of biotechnological conceptions of human nature in music cognition and neuroscience. It finds that while posthumanist and biotechnological frameworks share the premise of an "always already technological" human, and with that an interest in how biology and culture work together, the fields have drawn different implications from this new vision. Musicology and music sciences may both benefit by taking stock of the shifts in conceptualizing the human in each discipline, reflecting on what discrepancies between them reveal about the benefits and limitations of each perspective, and considering anew the possibilities for dialogue and collaboration.

KEYWORDS: music cognition, music and neuroscience, music and technology, musicology, music science, posthumanism, psychology of music, neurohumanities, vocal music

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In music historical scholarship, it is becoming common to conceptualize music as "always already technological" (Tomlinson 2015; Moseley 2016; Patteson 2016). Inspired by scientific and philosophical accounts in which there is no pretechnological human (Leroi-Gourhan [1964] 1993; Stiegler 1998), musicologists have begun to advance arguments that instrumental music-making may have preceded or emerged together with singing (De Souza 2014) or that anything capable of remembering or repeating music—whether within an organic body or external to it—is a form of technical mediation (Gallope 2011). Most recently, the interest in music's technological conditions and constituents has converged with a broader impulse across the humanities to decenter the human: taking up approaches of the kind articulated by the "nonhuman turn" (Grusin 2015) or "critical posthumanism" (Nayar 2014), musicological work in this vein has sought to reread musical repertoires for their nonhuman protagonists or processes, and to recognize nonhuman agencies in social life (Bates 2012; Burton 2017; Grant 2020; Morris 2019; Mundy 2018; Roda 2014; Watkins 2018).

Calls for posthumanist rethinking in the humanities often invoke "scientific advances" that have "exploded the concept of the human" (Braidotti 2013, 1) and that decades ago rendered "the last beachheads of [human] uniqueness" untenable (Haraway 1985, 68). Yet the sciences proceed no more monolithically than do the humanities, and reading music research in neuroscience, cognitive science, and psychology from a posthumanist musicological perspective, it is striking to see some of the most high-profile and grand-scale initiatives confidently championing a special music-human relationship. Consider two recent scientific ventures on the musical mind: the Natural History of Song (NHS) project announced by psychologists at Harvard University in 2016, and Sound Health, a partnership between the National Institutes of Health (NIH) and the Kennedy Center launched in 2017. "Music is a signature of the human experience," states the Natural History of Song website, a "ubiquitous, ancient, and uniquely human activity" (The Music Lab 2019, para. 2). The project thus took up the question of musical

universals—specifically, whether there are "core domains" of song (like lullaby) that appear regularly across human cultures, and whether such core domains have consistent features worldwide—by means of a "systematic investigation of the world's vocal music," which was enabled by their compilation and coding of ethnographic texts and audio recordings spanning a period of more than the last hundred years (The Music Lab 2019). And in 2017, the NIH and Kennedy Center held a workshop titled "Music and the Brain," bringing together neuroscientists, music therapists, and "supporters of the arts" to crystallize the Sound Health research priorities on how the brain processes music and the application of music in health settings. Their report on the workshop begins by quoting a plenary presentation's opening line: "Perhaps the most important problem in neuroscience is understanding what it means to be human, and music is an essential part of this" (Cheever et al. 2018, 1214).

To be sure, the linkage of music to an inborn, uniquely human nature receives its most poetic and prominent formulations in work aimed at general audiences, rather than at fellow scientific experts. One thinks of psychologist Daniel Levitin's popular books, such as *This Is Your Brain on Music*, in which we read that music provides "a window on the essence of human nature" (2006, 7), or learn, per the subtitle of another work, "how the musical brain created human nature" (2008). But such thinking is well represented in the scholarly literature as well (on this topic, see Kursell 2018). Cognitive psychologist Aniruddh D. Patel's more academic book *Music, Language, and the Brain* begins, "Language and music define us as human" and continues by stating that "when it comes to language and music […] our species is unique" (2007, 3).[1] When the aforementioned Natural History of Song researchers published their findings in *Science*, they expressed a hope of adding music to the list of known phenomena showing that "patterns once considered arbitrary cultural products may exhibit deeper, abstract similarities across societies emerging from universal features of human nature" (Mehr et al. 2019, 1).

The idea that "nature" and "universals" are—like the idea of "objective" knowledge about them—socially constructed, ideological, and historically wrapped up with colonial and patriarchal structures will be familiar to many readers, as will the observation that "music" is not a neutral category. Also familiar will be the typical tensions between scientific and humanities approaches, with their different epistemic aims and virtues. From such initial conditions, there are predictable ways for the disagreements between musical sciences and humanities to unfold, as the former pursue musical "nature," intent on the ways music might be biological, innate, and constrained, and the latter pursue musical "cultures," committed to the ways music is social, multiple, and open-ended (see Jacoby et al. 2020).

What I would like to excavate in this essay, however, is how changing conceptions of technology in relation to music and "the human" in musicology and in sciences of the musical mind have altered these fields in ways that yield new tensions and congruencies between them, while also presenting both new pitfalls and new opportunities for how they may proceed independently, in dialogue, or in collaboration with one another. This essay thus surveys musicological attention to technology and how it has segued into posthumanist paradigms; it also brings the resulting musicological lens to examples of scientific literature, so as to compare the rise of biotechnological and biocultural conceptions of human nature. Musicology and sciences of the musical mind may both benefit by taking stock of the shifts in conceptualizing music and the human that are taking place in each discipline, reflecting on what discrepancies between them reveal about the advantages and limitations of each perspective, and considering the implications for future work. This article thus focuses on technology as a catalyst to reconceptualizing the objects of study in recent musicology and the cognitive sciences, revealing some existing parallels, blind spots, and places where these fields may illuminate one another.

TECHNOLOGY BECOMES VISIBLE IN MUSICOLOGY

Around the year 2000, the "digital revolution" stimulated scholarship on music and technology that was interested in questions of how technology transforms musical practices and assumptions. A common thread through

much of this work was a sense that previous scholarship on technology had been problematically "determinist," ascribing to technologies the power to transform societies and individuals in unilateral, nonnegotiable ways. The remedy was social constructionism and kindred models that emphasized human agency in relation to technology—by, for instance, examining how engineers' values and assumptions were built into technologies, as well as how consumers or users adapted technologies to their own ends. As the music scholar and social-cultural theorist Timothy Taylor argued in his study of the ways digital technologies were shaping music production, distribution, and consumption, any music technology "both acts on its users and is continually acted on by them"; while engineers have designed into such technologies "specific uses, which are followed by listeners, […] at the same time, listeners through their practices undermine, add to, and modify those uses in a never-ending process" (2001, 38). In his study of how recording influenced musical activity, musicologist Mark Katz similarly explained how his account was not technologically determinist: "[T]he influence I describe does not flow in one direction only, from technology to user. As we will see throughout these pages, users themselves transform recording to meet their needs, desires, and goals, and in doing so continually influence the technology that influences them" ([2004] 2010, 3). Developing reciprocal understandings of human-technology influence was thus a common concern.

Though this scholarship focused on sound recording and digital technologies, thinking about how technologies are socially constructed and historically constituted opened the door to considering a wider array of material objects as technologies. As cultural studies scholars Jeremy Gilbert and Ewan Pearson (1999) observed in their work on dance music, many musical discourses blame technology for making music that is cold, lifeless, and emotionless, while at the same time celebrating the warmth, authenticity, and expressivity of musics that involve "just as many technological components in their production." They argued that "this contradiction is managed by means of the creation of a hierarchy within technology—what we might consider as an *index of visibility*." This index has to do with degrees of historical familiarity that users have with the technology and other contexts, which make some artifacts "considered *more* technological in status than others" (112). Discussing philosophies of technology and the phenomenology of music, musicologist Michael Gallope makes a similar point: that "we can only conceive of the musical object as something transcendental via a hierarchical evaluation of different musical technicities," and that "innumerable musical media have been rendered immediate, essential, or metaphysical" (2011, 59).

Among the "immediate," "invisible" technologies of music-making to become newly visible were musical instruments. Historian of science Karin Bijsterveld and arts researcher Peter Frank Peters (2010) argued that science and technology studies (STS) could contribute to the study of musical instruments, bringing to this field "theories of innovation" and ways of "understanding the mechanisms behind the creation and appropriation of novel technologies—musical instruments being one class of examples" (107). Within musicology, the habit of regarding musical instruments as transparent vehicles of composers' artistic ideas had been challenged by the historically informed performance movement (e.g., Bilson 1980; Skowroneck 2010). STS approaches further showed how instruments could be thought of as technologies formed through social negotiations.

Expanding the kinds of things that could be analyzed as technologies opened up opportunities to reinterpret musical works and think in new ways about music history. Scholar of early modern music-making Bonnie Gordon, for instance, argued that "in [Monteverdi's] *L'Orfeo* the power of instruments and technology influences the very conception of music, and music itself" (2009, 219). She highlights moments in the opera that demonstrate the character Orfeo's reliance on his lyre, finding the salient outcome of Monteverdi's musical dramatization to be not the defeat of vocal virtuosity (as previous interpretations had it) but the triumph of technology and its extension of human capacities. Throughout and surrounding the opera, Gordon finds celebrations of humans' capacity to alter their natural abilities through artifice, machines, and crafted instruments. Musicologists Linda Austern (2001) and Rebecca Cypess (2016) have also demonstrated how machines and instruments were celebrated in the early modern period of Western music history for their ability to enhance human powers, and explored the implications of this cultural assumption for the uses of musical instruments. Music historian Emily I. Dolan

(2013) has approached the orchestra as "a complex cultural and technical assemblage" (3), showing how it came together in the eighteenth century in ways that "radically altered how people listened to instruments and thought about their expressive qualities," one especially far-reaching consequence being the birth of the concept of timbre (2013). My own work on eighteenth-century Europe has shown the role of optical technologies in fostering new ways of listening to and thinking about music, demonstrating how they shaped the perception of specific musical works as well as romantic discourses about music as revealing other worlds (Loughridge 2016).

Attention to cultures of technology has been especially impactful for scholarship on the nineteenth century, where it has served to complicate the period's discursive—and musicology's inherited—antitheses between the organic and the mechanical, spirit and matter, subjectivity and objectivity, idealism and materialism, art and science. Dolan and science and technology historian John Tresch (2011), for instance, connect Richard Wagner's famed invisible orchestra to a tradition of "blindness toward technology and the rise of an abstract, ideal conception of music" (26–27). The joint attention of historians of music and historians of science to instruments, performance, mediation, and knowledge production has yielded analyses of the interconnections between musical and scientific developments in this period of industrialization and modernization, elaborated through special journal issues (Hui, Kursell, and Jackson 2013; Hibberd 2015), edited volumes (Davies and Lockhart 2017; Trippett and Walton 2019), and monographs (Brittan 2017; Davies 2014; Hui 2013; Jackson 2006; Kreuzer 2018; Steege 2012; Tresch 2012; Trippett 2013; van Rij 2015; Winter 1998).

This body of musicological scholarship has worked to recover material and embodied dimensions of music and to reveal the roles of technologies in changing musical practices, aesthetics, and modes of listening. It was not centrally concerned with a fundamental rethinking of or transformations in "humanness," but it is in this direction that attention to music technologies has increasingly pushed.

BECOMING POSTHUMAN?

"Most writing about the posthuman, especially in relation to popular music, revolves around human-technology hybridity," observes pop music scholar Justin Burton (2017, 9). The posthuman also connects to a broader set of challenges to conceptions of the human and to the humanities; work taking place in a variety of fields may be considered "posthumanist" for sharing interests in critiquing constructions of the human centered on ideas like rationality, autonomy, and control, or in working against anthropocentrism in the humanities. (For a sense of the broader scholarly landscape here, see Campana and Maisano 2016; McKittrick 2015; Tomlinson 2020; Weheliye 2014; Wolfe 2009). As our present concern is with the ways that scholarly attention to technology has led into rethinking music and the human, the version of posthumanism that revolves around technology will be my focus here.

The posthuman received what quickly became a canonical treatment in literary critic N. Kathrine Hayles's book *How We Became Posthuman* (1999). Hayles traced "how information lost its body"—that is, how it became common to imagine that information exists independently from material forms—through the mid-twentieth-century field of cybernetics. The disembodiment of information, she showed, was a crucial ingredient for a particular posthuman dream: that of bringing biological organisms and information technologies together into distributed systems across which human cognition and subjectivity is dispersed, toward an ultimate goal of transcending embodiment (a goal she critiqued). The cyborg—a human-machine hybrid envisioned by cybernetics researchers, and influentially theorized by feminist STS scholar Donna Haraway (1985)—emerges from this context as a prominent figure of the posthuman.

Music proved a potent means by which to experience others and/or oneself as newly posthuman in the sense of being merged with technology. Cultural theorist Kodwo Eshun, whose 1998 book *More Brilliant Than the Sun* developed a posthuman mode of music criticism, explained in an interview that he and fellow cultural

theorists in the mid-1990s "got a particular boost from music. Sonically, drum 'n' bass meant that we left the song far behind. […] [T]his obliged you to come up with a conceptual apparatus which was totally post-human" (quoted in Lovink 2013, para. 8). In a 2003 study of (then) recent popular music, musicologist Joseph Auner declared, "In no aspect of our lives has the penetration of the human by machines been more complete than in music" (99). Auner drew on Hayles's analysis of the posthuman and other cybertheorists to interpret the sound of processed voices in the music of Radiohead and Moby, demonstrating how these musicians shift the locus of expression from the human-sounding to the technological-sounding elements of their music. The result is a "submersion of the subject into a distributed system in which all the individual layers and components are allowed to speak" (116)—an effect that was disturbing to listeners invested in rock music's traditional construction of a self-expressive, self-determining individual, but that was already a norm within electronic dance music.

Developing "a different form of posthumanism than the one suggested by cybertheory" (namely by Hayles), critical theorist and Black studies scholar Alexander Weheliye (2002, 22) centered race in an analysis of pop music's human-machine relationships. Focusing on R&B, Weheliye demonstrated how the prominent presence of technology in both lyrics and sonic effects (such as processed vocals) makes the genre sound "machinic rather than traditionally 'soulful' or 'human'" (32). Weheliye situated this machinic orientation within a historical trajectory that differs from the one typically envisioned by cybertheory: where cybertheorists described the posthuman condition as a dispersal of once autonomous individuals into a distributed system, Weheliye drew attention to the historical withholding of humanity (including its presumptions of free will and agency) from Black people. The encounter with twentieth-century sound technologies thus plays out differently in the music Weheliye examines by Roger Troutman and Jodeci: there was from the start less investment in upholding a "natural human" by effacing music's technological components. His analysis shows that rather than "dispensing with the humanist subject altogether, these musical formations reframe it to include the subjectivity of those who have had no simple access to its Western, post-Enlightenment formulation" (40).

Auner and Weheliye illustrate that one appeal of the posthuman as a lens for cultural analysis has been its ability to challenge a naturalized conception of the "liberal humanist subject"—an autonomous individual with the power to act free from the will of others. Their approaches differ, however, in the scope of that challenge. Auner (2003) makes it clear that the effect of expressive machines and mechanized humans he describes is to create a "staged narrative" in which "there is always a human presence pulling the strings" behind the computer's voices (100). At issue is how cyborg personas are constructed through sound, while the White, male artists credited with making the music remain largely untroubled as figures of human autonomy. Weheliye (2002) too is concerned with how sounds "stage" human-machine relationships, but his account shows such stagings to be inseparable from the historical conditions of embodiment for Black people, and to unfold in relation to "the human" as a perpetually contested category that all along had versions other than the "liberal humanist" one.

Haraway had written that the cyborg is "a creature of social reality as well as a creature of fiction" (1985, 65), and Hayles that "we have always been posthuman," in the sense that in reality subjectivity has always been "distributed rather than located solely in consciousness, emerging from and integrated into a chaotic world rather than occupying a position of mastery and control removed from it" (1999, 291). As such theories began to be taken up in music studies, it remained an open question what it would mean for the field to take the posthuman seriously not only as a matter of performance and representation but also as a basis for conceptualizing people in the world.

One posthumanist move music scholars made was to elevate the agency and liveliness of objects to a point beyond how they shape the conditions of possibility for human action and thought. Ethnomusicologist Eliot Bates (2012), for example, argued for "taking objects, and particularly musical instruments, seriously—but not simply as things that humans use or make or exchange, or as passive artifacts from which sound emanates. Much of the power, mystique, and allure of musical instruments I argue, is inextricable from the myriad situations where instruments are entangled in webs of complex relationships—between humans and objects, between

humans and humans, and between objects and other objects. […] I thus am arguing for the study of the *social life of musical instruments*" (364, Bates's emphasis). In a themed issue of *Opera Quarterly* on machines, Gordon called into question the conceptualization of opera "as dependent mostly on the subjective experiences of composers, performers, and audiences" (2011, 1). She proposed that "to take machines seriously […] means moving, for a moment, from a subject- to an object-oriented approach. Opera is not only about composers and singers but also about the objects and things that animate it." Thus, "to understand the life of opera, we must understand the life of machines as well" (3).

Another way of following through the implications of the posthuman has been to interrogate processes through which differences between human and nonhuman have been historically produced. Music scholars Jason Stanyek and Benjamin Piekut, for example, refuse to assume that agency is something that distinguishes humans from nonhumans, and based in this view, they analyze how effectivity—making a difference, or having an effect—emerges in the recording studio with a study of the creation of Natalie Cole's recording of the song "Unforgettable." Drawing methodological inspiration mainly from STS scholars Bruno Latour (2005) and Karen Barad (2007), Stanyek and Piekut deploy a paradigmatically posthuman premise that "personhood is not equivalent to a lone body, but is distributed among and articulated with other entities that are textual, technological, juridical, and affective" (2010, 18). (On the significance of Latour for musicology, see Piekut 2014 and Dolan 2015.) Methodological inspiration for musicologists has also come from German media theory, where, as Bernhard Siegert argues, the guiding question has been "not *How did we become posthuman?* But rather, *How was the human always already historically mixed with the nonhuman?*" (2014, 6). Taking cues from Siegert, music historian Roger Moseley's (2016) study of keyboard playing shows play to be a phenomenon that precedes, makes, and confounds distinctions between human and nonhuman, player and played. Play is thus both "an intrinsic attribute of humankind" and common to animals and mechanical objects; "musical play forms (and is formed by) sequential processes that link humans to objects in ways that simultaneously configure the rules of play while making the conceivable and writeable as such" (3). Moseley extends Siegert's logic of the "always already […] mixed" from humans to music, framing "relations between 'music' and 'technology' by seeking to unlock not the impact of one on the other, but rather the ways in which technologies can be understood as always already musical—and vice versa" (68).

The shift in grounding assumptions behind these lines of thought can be illustrated by contrasting a premise associated with media theorist Marshall McLuhan with a posthuman premise from music theorist Roger Grant. According to McLuhan's mid-twentieth-century media theory (1964, 1967), as summed up by his colleague John Culkin, "we shape our tools, and thereafter our tools shape us" (Culkin 1967). For Grant (2020), articulating a critical posthumanism for music studies, "our instruments fashion us as we fashion them, and we learn to be who we are because of them" (5). The differences here are subtle yet consequential. In McLuhan's model, there is a human "we" who precedes the technologies—a pure humanity that sets the train of technological development and impact in motion. In Grant's formulation, the human "we" and the technologies are co-constitutive, producing one another from the beginning. This contrast between McLuhan's and Grant's operating premises is exemplary of what Siegert describes as the awakening of the humanities from their "anthropological slumber"—their mistaken belief that what preceded the cybernetic present was a pretechnological, non-hybridized "stable humanity of the human" (2014, 5).

Suspicions have been raised (by Devine and Valiquet 2017; see also Morris 2019) that musicologists' "nonhuman turn" has merely added some "things" into traditional accounts of human musical worlds, without ultimately troubling the categories of the human and nonhuman, or alternatively, that objects have surreptitiously replaced musical works as the locus of musicologists' aesthetic investment (Mathew and Smart 2015). A skeptical reader might not see posthumanist music scholarship revealing hitherto unrecognized agencies but rather a rhetorical game in which musicologists are, to recall Auner's reading of computer voices in pop music, the ever-autonomous humans "pulling the strings" within staged narratives of lively nonhumans and distributed systems.

Musicology is indeed in danger of going astray if it imagines that, by recognizing agencies in ever more nonhuman entities, it can finally arrive at complete, accurate, and just accounts of musical situations. Where it uses these debates—this surfacing of the grounds of discourse into the subject of discourse—to keep in view the implications of adopting one or another humanist or posthumanist premise, however, there are significant gains to be made. Discussing related issues in sound studies, for example, ethnomusicologists Gavin Steingo and Jim Sykes (2019, 13) argue that accepting the insight that "humans are always already constituted through relations to technical prostheses" would erase the supposed "distinction between premodern, nontechnological humans and modern, technological ones." This in turn "would imply a realignment of sound studies' boundaries" (13)—making it a global field that is able to engage with a wider array of material prostheses, rather than being delimited, as it currently is, largely by sound in relation to modern Western technologies. For music studies, the same insight could similarly help reconfigure the relationship between musicology and ethnomusicology, which has all too often appeared in institutional (including curricular) contexts in the guise of a split between a uniquely literate (hence technologized) Western music tradition and the rest of the world's music. (For a discussion of the problems with this split, see Tomlinson 2007, 359–360.) Even though music scholars reject differentiating musicology and ethnomusicology in terms of a modern "West" and non-modern "rest," the existing disciplinary structure works against conveying a more cosmopolitan common sense beyond our fields—including to our colleagues in the sciences.

"BECAUSE IT DOES NOT DEPEND ON TECHNOLOGY..."

In their *Science* article, the Natural History of Song team explained that they chose to "focus on vocal music (hereafter, song) rather than instrumental music because it does not depend on technology […] and has been the primary focus of biological explanations for music" (Mehr et al. 2019, 1).[2] The choice to focus on vocal music thus receives little more than a passing comment. To a musicologist such as myself who has followed the developments in thinking about technology and the posthuman outlined above, however, this comment leaps out, both for its dissonance with the posthumanist premise that there is no state in which the human or the musical is independent from technology, and for its uncritical relationship to the scientific tradition of using song to explain music. The comment is also indicative of a broader tendency in the NHS's experimental designs and interpretations to leave mediating technologies and processes out of account, which undermines the project's efforts to identify musical universals. The comment is thus a useful starting place for bringing musicological attention to technology and posthumanist thought into dialogue with music psychology and cognitive science.

To provide some historical perspective on the privileged place of voice in biological explanations for music: an intellectual tradition of explaining the origins of music as a natural process—as opposed to divine act—took shape in the eighteenth century. This was a period of substantial interest in how language originated but not in the origins of tool use. As anthropologist Gordon W. Hewes (1993) has observed, "[T]he numerous Enlightenment writers on human nature were impressed with the glorious progress of technology, but took its cognitive roots for granted, unlike their approach to the topic of language. […] [T]he question of how all man's tool-using skills had originated was still not considered to be a subject of profound intellectual importance" (24). Scholar of French music and literature Downing A. Thomas (1995), in his study of eighteenth-century theories of the origins of language, shows how thinkers turned away from notions of a "divine gift" to envision how language could have emerged naturally. The voice played a central role in these new theories of natural origin. Indeed, one might aptly characterize these theories as speculative histories of the human voice: beginning with a voice instinctively connected to feeling, they imagined processes through which instinctual cries developed into speaking—and into singing.

The eighteenth-century French philosophe Jean-Jacques Rousseau ([1781] 1998) offered a particularly robust account of how language and music developed out of vocal cries, and a number of scholars have recently traced the persistence of his theories in nineteenth- and twentieth-century thought about music's origins. As musicologist Jacqueline Waeber (2013) writes, the "Rousseauesque specter haunting […] scientific discourses" is the hypothesis that music and language share a common origin. This hypothesis, Waeber points out, is predicated on "a conception of 'music' originating as a vocalic phenomenon" (286). Charles Darwin adopted this conception of music as a given, bequeathing it to subsequent evolutionary theorists of music (Kleinman 2015). Music theorist Jonathan De Souza's (2014) survey of early twenty-first-century scientific literature on music's origins demonstrates that the assumption that it originated with the voice has remained axiomatic.

That music is universal was already widely assumed prior to the eighteenth century, but its universality had been predicated on notions of universal harmony, a divine cosmic order (Chua 2001; Welch 2014). Musicologist Matthew Gelbart (2013) showed how "Rousseau reframed the concept of musical universality by addressing 'nature' in music as *human* nature more than as physical properties of the universe" (280). With views shaped by the period's colonial enterprises (see Bloechl 2008), Rousseau envisioned human nature as universally shared human capacities or potentials, which develop in culturally specific ways shaped by climate. Gelbart (2013) suggested that Rousseau's novel conceptualization of the universal in music—the "transfer of universals to the realm of human nature and human reactions" (283)—became the basic operating assumption of subsequent work on musical universals. Human nature as Rousseau imagined it not only contained the potential for music but was also technology free. In his 1964 book *Le geste et la parole* (Gesture and speech), paleontologist André Leroi-Gourhan identified Rousseau as "one of the first to outline a 'cerebralist' theory of human evolution," by which Leroi-Gourhan meant that Rousseau envisioned an original, "natural man" who starts out with all the mental faculties of present humans but no technical equipment; this "natural man," then "gradually invents everything within the technical and social order that will lead him to the present-day world" ([1964] 1993, 10). Against this view, Leroi-Gourhan developed an account of the prehuman tool-maker, and what has come to be called a theory of "biocultural evolution."

French philosopher Bernard Stiegler's view of humans' originary technicity—a view embraced, as we saw above, by some musicologists—built on Leroi-Gourhan's theory and elaborated his critique of Rousseau. The latter imagined an "originary man" who walked on two feet and who made use of no tools, his body being "the only instrument he understands" (Rousseau [1754] 1992, 53 quoted in Stiegler 1998, 115). This, for Stiegler, is a contradiction that exposes Rousseau's error: for at the point of standing upright, hands became free for tool use and the mouth (previously busied with grasping) became available for verbalizing; walking on two feet and tool use are therefore coterminous. Stiegler thus argues that Rousseau "went astray in thinking that technical exteriorization was an exit from the movement of pure nature" (1998, 162). Recognizing this as an error provides a different understanding of the human and a different view of evolution, in which technology does not exist outside or after the biological. As Stiegler writes, "[T]he evolution of the 'prosthesis,' not itself living, by which the human is nonetheless defined as a living being, constitutes the reality of the human's evolution"; hence "the evolution of this essentially technical being that the human is exceeds the biological, although this dimension is an essential part of the technical phenomenon itself" (1998, 50). On the basis of this view, "anthropogenesis corresponds point by point to a technogenesis" (45)—that is, biological development is always coupled to technological development.

De Souza (2014) drew upon Stiegler's view of evolution to develop an account of music's origins in which "human vocal ability would not precede the ability to make music with objects" (30), but rather "music is essentially technical[,] and vocal and instrumental capacities emerged together" (22). De Souza found additional support in the work of neuroanthropologist Merlin Donald (1991, 1999), who has argued that the same capacity for deliberately rehearsed motor behaviors underlies both tool use and intentional vocalizations. De Souza thus endorses speculations like that of David Burrows (2007), that singing with stable, discrete pitches could have resulted from imitating instruments like the xylophone, where discrete pitch is built in.

Though critical of Stiegler, musicologist Gary Tomlinson (2015) too critiques the Rousseauesque tradition, offering in its stead a rigorous proposal for how musical capacities emerged over one million years of hominin evolution.[3] In Tomlinson's account, the voice remains central but its conceptualization is different: it is technical in nature and inseparable from tool use. Tomlinson argues that long before anything we could call music, there emerges an "early hominin voice" that shifts from innate calls toward voluntary control and social complexity, becoming "a construction molded […] by encounters with others" (2015, 89). Tomlinson calls the stage of communication that marks this shift "protodiscourse" and suggests that it "probably recruited and extended the capacities that underpinned toolmaking" (128).

Perhaps we would do well to maintain a balance of skepticism and openness toward accounts of the origins of music. The sparseness of evidence for how music originated means that any account is highly speculative and involves the projection of cultural assumptions. The reasons for privileging the voice in biological explanations of music have had little to do with empirical evidence, and entertaining other formative sites of musical behavior provides new avenues for investigation. While a turn to hands and tools opens up possibilities for the discovery and interpretation of evidence, however, we should not imagine that researchers have escaped from old, limiting cultural assumptions into an assumption-free zone. Rather, the emerging theories about music's origins can be seen as part of a broader shift in cultural assumptions, through which music has changed from something that springs from a pretechnological human nature to something that springs from human interactions with technologies.

We may, then, wish to conclude that the evolutionary and philosophical challenges to the idea that vocal music "does not depend on technology" remain speculative, and do not foreclose its validity. However, there are other, concrete ways in which the notion of "not depend[ing] on technology" presents problems in the context of the Natural History of Song research. For one, the NHS study of vocal music is in fact a study of its transcriptions and recordings—distinct technological instantiations of music, with each artifact having been shaped by the people and conditions involved in its making. The marquee publication of the NHS (Mehr et al. 2019) arrives at many compelling results through statistical analyses of their archive but also makes claims that are rendered suspect by their minimization of, or blindness to, the mediating processes that have shaped their data. For instance, the researchers provide several "exploratory analyses," one of which finds that "signatures of tonality appear in all societies studied." Their brief discussion of factors that limit the generalizability of this finding includes the observation that "the transcriptions were created manually and *could have been influenced* [emphasis added] by the musical ears and knowledge of the expert transcribers" (14). The transcriptions were certainly influenced by the musical ears of the transcribers (a point to which I shall return), as well as by the affordances and constraints of the notation system. (On transcription, see Goodman 2018; Kursell 2018; Seeger 1958; for discussions of comparable critiques of Alan Lomax's Cantometrics project, which likewise sought to compare songs from around the world, see Averill 2005; Savage 2018).

Despite the apparent ability of audio recordings to redress the inability of notation to capture the full sonic presence of a musical event, recordings too are neither transparent nor neutral. The period when phonograph recording was first being used by ethnographers is particularly revealing of assumptions and values that conditioned the medium's meanings and uses. German and media studies scholar Eric Ames (2003) has shown how these ethnographic recordings were shaped by the quest for establishing evolutionary lines of development, from "primitive" non-Western music to that of the "civilized" West. Music scholar Alexander Rehding (2005) has examined debates about the status of phonographic recordings as musical evidence—for instance, the dispute about the question of whether features such as pitch fluctuations were essential to a song or musical system, or whether they were accidental features of a performance. Music scholar Daniel Walden (2018) has addressed the "single-minded focus on pitch" in this period of music ethnography, showing how phonograph recordings were used together with tools like Helmholtz resonators, musical keyboards, and notation to extract pitch from timbre. Cornelia Fales (2002) describes a case that illustrates well how an ethnographer's musical perception

shapes the translation of a musical practice into the archive, even with the "mechanical objectivity" of sound recording. In her study of Burundi whispered *inanga*, Fales shows that in recordings of the genre made by Alan Merriam in 1950, the microphone was placed near the instrument, and as a result the whispered vocals were rendered largely inaudible. As Fales argues, this microphone placement betrays "the subtle bias of what has come to be called 'pitch-centrism' or 'timbre deafness,' a perceptual proclivity on the part of western listeners, including ethnomusicologists, to focus on melody in music where the dominant parameter is timbre" (2002, 56). In their study of Tuvan music, such as throat singing, ethnomusicologists Theodore Levin and Valentina Süzükei (2006) also discuss the discrepancy between Western pitch-centric perception and the "timbral listening" practiced by Tuvan musicians (47), and Levin supplies an example of how his musical preconceptions distorted his audio recording of the musical practice (53–54).

Audio recordings thus prove revealing of the perceptual biases of the recorder, pointing to their imbrication with another level of mediation: the cultural knowledge shaping perception. Recent work in cognitive psychology offers a general model for how categories shape perception. Cognition researchers Gary Lupyan and Andy Clark (2015), for example, use the term "predictive processing" to refer to the mechanism by which the knowledge that a person has may change what that person perceives, including the ways that language affects perception, thought, and action. As they explain, experiences are informed by "*priors* (prior beliefs, usually taking the form of nonconscious predictions or expectations)" (279). This model thus accounts for the cultural production of perception and indicates how important it is to consider the role of priors, with language being a site where they may be rendered observable. Musical listening can be seen to be full of priors, with the pitch/timbre distinction in Western music providing a prime example (Walden 2018; Wallmark and Kendall 2018).

Bracketing the issue of how the sonic data in the NHS archive was shaped by the "musical ears" (that is, the culturally shaped perception) of the people recording it, we might yet ask: does it matter to claims about musical universals if two listeners perceive the same music differently—not merely in the sense of deriving different meanings from it but in a psychoacoustic sense of hearing, for instance, distinct pitches or a timbre? The Natural History of Song publications to date do not entertain such questions, for the most part steering clear of the potentially confounding factor of cultural variation in musical perception. Yet one of the key results to come out of the NHS research was the finding that listeners could, at rates better than chance, identify lullabies, dance music, and healing songs cross-culturally. Summarizing studies that tested the cross-cultural ability to recognize function or emotion in music, Mehr et al. (2019) write: "These studies suggest that the form of music is systematically related to its affective and behavioral effects in similar ways across cultures" (1), and they use this to "propose that the music of a society is […] the product of underlying psychological faculties that make certain kinds of sound feel appropriate to certain social and emotional circumstances" (3).

More attention to mediating processes calls this proposal into question. To find a cross-cultural capacity to recognize lullabies, dance music, and healing songs, Mehr et al. (2018) employed an experimental design that had subjects listen in relation to a set of six possible "functions," with the listener asked to rate the likelihood that each musical example was used "for dancing," "to soothe a baby," "to heal illness," "to express love for another person," "to mourn the dead," or "to tell a story" (361). Taking seriously the cultural production of the senses and the relationship between language and perception, the potential problems with this experimental design become evident. Psychology researchers Nicole Betz, Katie Hoemann, and Lisa Feldman Barrett (2019) have critiqued similar experimental designs in emotion research. As they observe, when emotion perception is tested in different cultures by means of forced-choice tasks, the resulting agreement above chance levels is "interpreted as evidence that certain facial configurations are universally recognized as emotional expressions" (1463). But when the experimental design asks people to freely label facial cues rather than to choose from a limited set of words, agreement declines often to mere chance—a finding that raises doubts about the discovery of universally recognized emotional expressions. Betz et al. point to "predictive processing" as a model that could explain how the multiple-choice format influences perception, since it accounts for how words shape mental inferences.

The main solution NHS envisions for cultural variability in perception is to check or remove such subjectivity by means of algorithmic automation. To test the universality of tonality, they asked "expert listeners" if they heard a tonal center, and if so, what its pitch class was. Since their judgments "could have been influenced by [their] musical ears and knowledge," however, they also used a key-finding algorithm to provide "converging, objective evidence for the prevalence of tonality in the world's music" (Mehr et al. 2019, 14). From the fact that the algorithmic key identification agreed with that of the human listeners (85.6% of the time if one considered what the algorithm identified as the best fitting key, 98.3% if one considered its top four matches), the researchers concluded they had "convergent evidence for the presence of tonality" (14). Additionally, they suggested that for future studies, machine listening could solve the problem of biased human ears in the making of transcriptions: "current music information retrieval algorithms are not robust enough to transcribe melodies accurately, especially from noisy field recordings, but improved ones could address this issue" (14).

Like recordings, algorithms conjure but do not deliver a human-free "mechanical objectivity" on the world. The work of STS scholar and anthropologist Nick Seaver on music recommendation algorithms has been particularly illuminating on this new frontier of automation. Through ethnographic work on how algorithms are made, Seaver (2018) shows that contemporary algorithmic systems work through "a steady accumulation of feedback loops, little circuits of interpretation and decision knit together into a vast textile. Every stitch is held together by a moment of human response, a potential rejection shaped by something outside the code" (377)—be it a personal preference or a broadly shared evaluation framework. Regarding algorithms not as "autonomous technical objects" but rather as "complex sociotechnical systems" (378), it is harder to subscribe to the idea that they remove the ways musical perception is shaped by cultural knowledge.

MUSIC: ADAPTATION OR TECHNOLOGY?

The previous section briefly explored some of the history of the commonsense assumption adopted by the Natural History of Song that "vocal music […] does not depend on technology" (Mehr et al. 2019, 1), as well as recent challenges to that assumption. My arguments connected these recent challenges to a shift from assuming that music springs from a pretechnological human nature to assuming music springs from human interactions with technologies. This section now traces this shift in conceptualizing music through select scientific literature, providing more of the context for the NHS paradigm (which, it will be seen, is consistent with the state of the field in the early 2000s) and considering how the incorporation of technology into "the human" is shaping current endeavors, such as the Sound Health initiative.

Consider two influential books, one from either side of the humanities/sciences divide: ethnomusicologist John Blacking's *How Musical Is Man?* (1974) and psychologist Steven Pinker's *How the Mind Works* (1997). They represent opposite views on the relation of music to the human species. For Pinker, music is inessential, being fully dispensable from the perspectives of both human evolution and present-day life. As he writes, when it comes to "biological cause and effect," "music is useless"; it "could vanish from our species and the rest of our lifestyle would be virtually unchanged" (528). For Blacking, in contrast, music is fundamental from both biological and societal perspectives. As he writes, "[M]usic may be related to basic human drives and to the biological need to maintain a balance among them" (100). Blacking supports this view with the contention that there "seem to be universal structural principles in music" (1974, 112), which suggest that "at the level of deep structures in music there are elements that are common to the human psyche, although they may not appear in the surface structures" (109). Blacking thus proposed that "the chief function of music in society and culture is to promote soundly organized humanity by enhancing human consciousness" (100).

As ethnomusicologist Suzel Ana Reily (2006) has observed, Blacking's "vision of the human species as naturally musical has become the most enduring legacy that John Blacking bequeathed to ethnomusicology"

(1), even if, as Reginald Byron (1995) noted, his "sweeping assertions […] about the innate musical capacities of humankind" sometimes rested on slender evidence (Byron 1995, 17–18, quoted in Reily 2006, 2). In fact, it was to Blacking that critics of Pinker's claims about music often turned. In his initial counterargument to Pinker, provocatively titled "Is Music the Most Important Thing We Ever Did?" (1999), and in subsequent publications, Ian Cross (2001, 2007, 2015) enlisted Blacking in both a critique of Pinker's ethnocentric assumptions about music and in the formulation of a central puzzle: why would music be "humanly universal" if it has no relation to human evolution? Cross hypothesized that music played essential evolutionary roles by uniquely contributing to the development of mental agility and complex social interactions, suggesting that "without music, it could be that we would never have become human" (2001, 101).

While Blacking and Pinker have become touchstone figures for opposing views on music's biological significance, their books nevertheless share a common view of "technology": technology is outside, apart from, or "Other" to nature, biology, and whatever is essentially "human." Thus Blacking regularly contrasts music and technology, as when he claims, "The rules of musical behavior are not arbitrary cultural conventions, and techniques of music are not like developments in technology" (1974, 100). Meanwhile for Pinker, the conceptual dichotomy between the biologically human and the technological means that we should understand music as a technology. Thus, he writes, "[M]usic appears to be a pure pleasure technology" (1997, 528); unlike language, music "is a technology, not an adaptation" (529). The framing of *natural human vs. artificial technology*, common to Blacking and Pinker, makes the question of the nature of music turn on deciding to which side of that dichotomy music belongs.

As music cognition researcher Henkjan Honing et al. (2015, 1) observe, Pinker's remarks on music "revitalized interest in the origins of music and its relevance for the biological and cognitive sciences." Reviewing this burgeoning research area in 2005, cognitive scientists Josh McDermott and Marc Hauser set forth the criteria that they argued must—and potentially could—be met in order to establish that music is an evolutionary adaptation. Their criteria exemplify the field's orientation at this juncture toward isolating biological capacities for music in the brain. If it were the case that aspects of music are "acquired by general learning mechanisms through exposure to a culture," this would "preclude an evolutionary story about music." They were instead after an "innate mechanism," which they suspected might exist based on "certain key features of music" (30). A musical capacity or preference being demonstrably innate rather than learned was one key requirement for a music-specific adaptation, because only innate components of music could be considered targets for natural selection. The other key requirement was that the capacity or preference be uniquely human. This "uniquely human" status was necessary because those musical capacities that were shared by other animals could be regarded as latent in the animal brain and merely recruited for music in human brains, after having evolved for other purposes by common ancestors (as in the case of general learning mechanisms). We can see the "uniquely human" requirement at work in McDermott and Hauser's discussion of a study by Anthony Wright et al. (2000), which showed that rhesus monkeys were able to recognize tonal melodies transposed at the octave as the same but were not able to recognize atonal melodies so transposed. From this demonstration of melodic sensitivity in a nonhuman primate, McDermott and Hauser concluded that because rhesus monkeys "do not produce or experience music on their own," they "clearly did not evolve musical sensitivity for the purpose of listening to or producing music, which means that their sensitivity must be the byproduct of a mechanism evolved for some other purpose" (2005, 44). Telling an "evolutionary story about music" in this framework thus envisioned identifying a neural mechanism for some key feature of music that was both innate and unique to humans—part of a purely human nature, independent from both the cultural and nonhuman animal.

Amidst the debates over whether music was an evolutionary adaptation or not, dissatisfaction with the question's bifurcating framing emerged. Cognitive psychologist Laurel Trainor (2006) has asked whether it is possible, when analyzing complex cognitive abilities like music, to distinguish between capacities that were direct targets for natural selection and those enabled by traits adapted for other purposes. In particular, Trainor

argued against dichotomizing the innate and the learned, as McDermott and Hauser, and others, have done. Observing that unique aspects of music seem to depend on both innate constraints and learning, she advocated for a focus on "how learning and innate constraints work together" (106). Without the ability to isolate the innate from the learned, Trainor observed, "a determination of whether music is an evolutionary adaptation will depend on new ways of approaching the question" (108).

MUSIC: A TRANSFORMATIVE TECHNOLOGY OF MIND?

As if in answer to Trainor's charge, cognitive neuroscientist Aniruddh D. Patel's 2007 book *Music, Language, and the Brain* charted an alternative path through the evolutionary debate, proposing a novel resolution to the mystery of why music would be a human universal if it were not a product of evolutionary forces (that is, if it were indeed useless from a biological perspective). Pinker, Patel argued, had offered a false dichotomy between "adaptation" and "frill, a hedonic diversion that tickles our senses and that could easily be dispensed with" (400). There was a "different category" to which music might belong, a category for things that were "an invention based on human ingenuity" (as opposed to a direct "target of evolutionary forces") but that nonetheless became integral to human life (356). Patel dubbed this category "transformative technology." Where spoken language, Patel argued, was a direct target of evolutionary forces, written language was the prime example of a transformative technology: it was transformative in making it "possible to share complex thoughts across space and time and to accumulate knowledge in a way that transcends the limits of any single human mind" (400). And "as with other transformative technologies," Patel argued, "once invented and experienced, it becomes virtually impossible to give it up." Music is thus "something that we invented that transforms human life." Fire is another "transformative technology," and it is by analogy with fire that Patel explains how music can be universal while also being an invention, rather than a product of evolution: like fire, "what it does for humans is universally valued" (401).

In a subsequent publication, Patel (2010) further refined this conceptualization of music: he now dubbed it "a transformative technology of the mind." Patel's 2007 treatment had rendered music transformative in diffuse ways—it was transformative of "human life," its impacts nebulously distributed across individuals and society. Now, Patel argued that music was "biologically powerful," in the sense that musical behaviors had lasting effects—on the order of months or years—on brain functions beyond those directly involved in the musical behaviors in question. Patel maintained his argument, however, that music—unlike language—was not a target of evolutionary forces: his "transformative technology of the mind" theory did not posit evolutionary modifications of the brain specifically aimed at facilitating musical abilities; rather it described music "as a technology that is learned anew by each new generation of human minds" (2010, 95). More recently, Patel has updated his theory to allow for "gene-culture coevolution"—the possibility that after music first emerged, it became a target of evolutionary forces, giving rise to specialized neural mechanisms by means of "feedback loop[s] between human cultural practice and lasting changes in human biology" (2018, 116).

Patel thus agrees with Pinker in deeming music a technology but differs with him on the biological significance of this technology. Paradoxically, a risk of conceptualizing music as a technology is to efface the technologies involved in making it. Emily Dolan has observed a similar phenomenon with regard to the commonplace conceptualization of music as an art whose medium is sound, which by physiological analogy would be like regarding painting as an art whose medium is light. In the idea that sound is a medium for music, she argues, "lies a host of additional assumptions, practices, and conventions": "to treat sound as a musical medium skirts musical technologies; better put, it stands in for the technologies that have been bypassed" (2012, 3). Conceptualizing music itself as a technology relies on and performs this same stand-in operation, setting researchers up for the kinds of blindness to the technical components and mediations of music demonstrated by the Natural History of Song team.

Beyond differing with Pinker on the biological significance of music, Patel also put forward a different conception of "the human." The *adaptation vs. technology* framing inherited the assumption of "a stable humanity of the human" (to recall Seigert), a Rousseauian assumption described by Stiegler, that "the nature of man is not in the way he changes. There is, there has to be, a nature of man before change" (106). Patel's "transformative technology of mind" instead made way for a human nature that is fundamentally about change—change by means of technology. As Patel claimed, "*Homo sapiens* is unique among all living organisms in terms of its ability to invent things that transform its own existence" (2007, 400).

For this understanding of human nature, Patel drew on the work of Andy Clark. In his 2003 book, Clark, a philosopher of mind and cognitive science, provides a synthesis of recent scientific findings, technological developments, and thought experiments, all packaged with claims about what it is to be "human." (Recall that Patel's book began, "Language and music define us as human" [2007, 3].) Clark's key claim is perfectly summed up by the book's title: humans, he argues, are *Natural-Born Cyborgs*, "human-technology symbionts" (3). Patel cited Clark's book to support his statements: "this never-ending cycle of invention, integration, and transformation is uniquely human" and "the human process of invention, internalization, and transformation can change the very organ that makes this process possible" (2007, 401).[4]

If "posthumanist" scholarship entails a commitment to decentering the human, we might describe Clark's cyborg theory as resolutely humanist. The "tendency toward cognitive hybridization," he argues, "is an aspect of our humanity, which is as basic and ancient as the use of speech" (2003, 3–4). This cyborg nature thus becomes the *sine qua non* of the "uniquely human," of "our special, and distinctively *HUMAN*, nature" (3, Clark's emphasis). His book is dismissive toward the work of feminist cybertheorists, and he fashions himself as the heroic discoverer of a hidden reality: "I'd encountered the idea that we were all cyborgs once or twice before, but usually in writings on gender or in postmodernist (or post postmodernist) studies of text. What struck me in July 1997 was that this kind of story was the literal and scientific truth" (4). He thus sought to "hijack" the image of the cyborg and to reveal it "as a disguised vision of (oddly) our own biological nature" (4). Clark's "natural-born cyborg" thus does away with the pretechnological human, as does posthumanist scholarship, but it also preserves the human exceptionalism from which much posthumanist scholarship has sought to move away. This reconciliation of the cyborg to the uniquely human helps explain why the paradigm is an appealing fit for sciences of the musical mind, with their established investment in the idea that music is somehow related to and revealing of "human nature."

TOWARD BIOCULTURAL BEINGS

Changing the conception of human nature from pretechnological to always already technological, from stable core to propensity for transformation, has shifted the terrain for research agendas and alliances. Within music science, a sign of this shift is the newfound momentum behind efforts to bring basic and applied fields together. As recently as 2015, music therapist Wendy Magee and psychology researcher Lauren Stewart observed that collaborations between neuroscience and music therapy "are not considered mainstream" (1) and that "there is very little infrastructure to allow these two disciplines to interact in ways that can reciprocally inform each other" (2). The following year, however, at least two collections of research papers were aimed precisely at such interactions (O'Kelly et al. 2016; Särkämö et al. 2016). Soon after, the National Institutes of Health and the Kennedy Center launched a major new institutional support structure called Sound Health.

Sound Health aims to bring together two research areas that had previously been separate—on the one hand, research on "basic and mechanistic" (Cheever et al. 2018, 1217) dimensions of the musical brain, and on the other hand, clinical applications of music. Conceptualizing music in relation to human transformation, rather than in relation to a static essential nature, opens up possibilities for merging the applied goals of Sound

Health with that "most important problem in neuroscience," which plenary speaker Robert Zatorre identified as "understanding what it means to be human" (quoted in Cheever et al. 2018, 1214). When answers to the question of "what it means to be human" involve both music and transformation, they become compatible with the goals of treating diseases, as well as with those of developing "scientifically based strategies to *enhance normal brain development and function* [emphasis added]," another major objective of the Sound Health initiative (Cheever et al. 2018, 1214; see also National Institutes of Health 2018).

If recent openings of human nature to technology and transformation have helped make Sound Health possible, however, other facets of the project suggest that the human vs. technology paradigm may flourish in this initiative and similar ones. The interest in "basic and mechanistic" dimensions of the brain described by Sound Health includes identifying "neural circuits" involved in music and exploring "the possible evolutionary benefit of music to *Homo sapiens*" (Cheever 2018, 1217; see also National Institutes of Health 2018). These goals could be pursued in the manner we saw described by McDermott and Hauser (2005), directing efforts toward finding innate "circuits" for music that are unique to humans. The evidence for music's effects on well-being can also be leveraged circularly to support existing theories of music's place in human evolution, as it is by cognitive archaeologist Steven Mithen. Connecting the theory he developed in his book *The Singing Neanderthal* (2005) to the question of why music is good for well-being, in a recent interview Mithen envisions musical communication and community before language: "We couldn't have invented agriculture, or cities, or had an industrial revolution without language. But that all causes us some degree of mental stress, unhappiness, and so forth. And music takes us back to a time when that was the primary nature of being human—and we can still recover that in ourselves. And it gives us a sense of well-being, and calmness, and engagement." With Rousseauesque reasoning, Mithen hypothesizes a purely vocal musicality "that has remained as part of our nature of being," and he proposes this primordial essence as the basis for music's health-promoting powers today (quoted in Biancolli 2021).

Another way in which the agenda set forth by Sound Health may yield not only new research paths but also replays of the past was intimated at a press briefing on music and health at the 2020 annual meeting of the American Association for the Advancement of Science, where one researcher pondered: "[W]ill there be a future day when you prescribe ten minutes of Mozart listening to a patient with Alzheimer's? We don't know, but I think that we're starting to find out that relationship and what that might look like" (neuroscience researcher Psyche Loui quoted in Cohen 2020, last para.). The future conjured here recalls the "Mozart makes you smarter" phenomenon of the 1990s. Writing about this scientific misadventure, cognitive scientist Elizabeth Margulis (2019) observed that "the impression that science had identified special brain-boosting power in Mozart proved difficult to retract" (109). Bespeaking an implicit theory that children could be "mystically pulled in edifying directions" by the sounds of Mozartian genius, the misinterpretation of the research demonstrated "the power of underlying cultural assumptions about the mysterious genius of the classical period's canonical composers, and the embodiment of this genius in the sounds of their music" (109).

The road to more rigorous science does not lead to expurgating all cultural biases, a quixotic quest if ever there was one. Rather, within "the power of underlying cultural assumptions" lies a whole world that cognitive and neuroscientific research is only beginning to explore. An example of what music science in this direction can look like comes from a study by cognition researcher Gökhan Aydogan and his colleagues (2018), which showed the impact of priming information on musical pleasure. The study found that people reported greater enjoyment of a musical performance when they were told beforehand that it was by a world-renowned pianist, versus when they were told it was by a conservatory student. Functional MRI scans showed the brain mechanisms behind this effect: reward pathways involved in pleasurable experience began to engage when the listener was told that they would hear a world-class performer, and these fired even before the performance had started. The study thus demonstrated both the impact of priming, contextual information on musical enjoyment and the neural correlates of that impact.

Another example comes from a study of rhythm perception by cognitive scientist Nori Jacoby and Josh McDermott (2017). Jacoby and McDermott developed a method to test "perceptual priors"—internal biases that constrain what can be accurately perceived and reproduced. They asked listeners to reproduce a simple rhythm and then used each listener's execution of the rhythm that they played as the example they were once again asked to reproduce. By repeating this process, the rhythm over time became "dominated by internal biases" (2017, under "Summary"). Jacoby and McDermott used this procedure to compare US listeners with Tsimané listeners from the Bolivian Amazon basin. They found that both US and Tsimané study participants drifted toward rhythms in integer ratios, but in ways that were distinct—that is, they found that these two groups had differing perceptual priors for rhythm. The cross-cultural findings suggest that rhythm priors are not fixed by biological constraints but rather are substantially shaped by experience. An additional experiment comparing musicians and nonmusicians in the US found little difference between these two groups, suggesting that rhythm priors are developed through passive exposure to music. By thus probing mental representations, the study has implications for the transmission of cultural patterns, pointing to cognitive mechanisms that enable learning to favor certain patterns over others.

These studies exemplify, I would suggest, what cognitive scientists Catherine Hartley and David Poeppel (2020) envision for a "productive neurohumanities research program": such research would "include the study of systematic ways in which subjective experience is influenced by prior knowledge" and "seek to provide an account of the biological embedding of an individual's context and culture" (599). To frame the research this way leads us back to thinking about technology and why for music studies (perhaps especially, perhaps emblematically) it can provide a bridge between the concerns and methods of scientists and (post)humanists. Across these disciplines, technology has gone from nominating what is external to music and human to being both an instigator and a sign for thinking about how external worlds (e.g., "context and culture") become embedded in bodies and minds. Recognizing this commonality suggests opportunities for mutual interest and collaboration. As musicologist Carolyn Abbate (2016) has pointed out, humanities scholars have sometimes been incautious in claiming biologically transformative powers for technology: they have "taken for granted that instruments and technologies have the power to alter and reshape (here in descending order of plausibility and demonstrability) attentiveness and perception, or the human sensorium—the brain's 'seat of the senses'—or the ear and eye themselves, the biological organs" (799). Conversely, as we have seen with the Natural History of Song, scientific researchers have sometimes been incautious in disregarding the power of technologies, context, and culture to alter and reshape perception.

The Natural History of Song is once again instructive here for comparing the different assumptions and implications entailed by different paradigms. Among the candidates for a "core domain" of song identified by the project is "healing songs." The proposal that these could reflect cross-cultural regularities grounded in human psychology is buttressed by the prevalence of songs in shamanic practices and by team member Manvir Singh's "theory of shamanism based in universal cognitive dispositions and cultural evolutionary processes" (2018, 2). A feature of Singh's theory is the assumption that shamanic traditions need to be explained via "the psychology of superstition," because this is what "sustains beliefs in ineffective interventions" (4). As biologist Aaron Blackwell and anthropologist Benjamin Purzycki argue in their commentary on Singh's theory, however, shamanic traditions can be effective, and their efficacy at treating disease and promoting healing deserves consideration in an account of how such traditions evolved (2018). As cognitive scientists Michael Hove and Johannes Stelzer (2018) point out in their commentary on Singh's theory, the musical elements of "the theatrical and ritual aspects of shamanic practices can strengthen the patient's belief in the shaman's power […] and in turn maximize psychoneuroimmunological effects for healing" (26). This line of reasoning has significant implications for Sound Health's aim of "pinpoint[ing] in the brain how music therapy works" (NIH director Francis S. Collins quoted in National Institutes of Health 2019). It calls for consideration of how the existence of the Sound Health initiative itself—with its institutional authority transferring the cultural legitimacy of "hard science"

to the therapeutic powers of music—could enhance the efficacy of music in clinical health applications. And it suggests that to "pinpoint in the brain how music therapy works" would therefore require registering such enhanced efficacy not as fake or fictitious but as a facet of biocultural processes.

CONCLUSIONS

As Jacoby et al. (2020) observe, "[R]esearchers are integrated into disciplinary subcultures with different assumptions and goals," which "need to be rendered explicit to facilitate communication across disciplinary divides" (186). This essay has endeavored to make explicit the differing assumptions about technology in relation to music and the human that humanists and scientists hold, showing how recent revisions in these assumptions have brought these groups into closer agreement in some respects, while giving rise to new tensions in others. Where the "always already technological" human supports some common ground for thinking about the imbrications of biology and culture, the tensions become apparent when considering the different uses to which this vision of humans has been put. Steingo and Sykes (2019), for instance, highlight the potential for this vision to offer a salutary corrective to visions of non-modern humans inhabiting the non-Western world. For Stanyek and Piekut (2010), conceiving personhood as distributed rather than neatly bounded is part of a move beyond human exceptionalism. By contrast, the "always already technological human" serves in the context of Clark's narrative to render inevitable the enrollment of humans into ever more and tighter "biotechnological unions," because that enrollment is grounded in what he sees as "our basic *human* nature [Clark's emphasis]" (198). Rather than settling comfortably into our new paradigms, then, we might use such discrepancies as an aid to think critically about them. Observing an eighteenth-century moment when interest in "the human" flourished, literary scholar James Robert Wood (2019) suggests that certain writers were "well aware of human nature's status as a kind of mental fiction that allowed the work of reflecting on oneself and on others to proceed" (22). With such a dose of epistemological humility, musicologists and music scientists may find ourselves at a fresh juncture for dialogue and collaboration around questions of mutual interest.

NOTES

1. Bracketed ellipses are used throughout this essay to indicate omissions from quoted text.
2. The phrase omitted here, "has well-defined physical correlates [i.e., pitched vocalizations]," seems to me neither here nor there.
3. Tomlinson (2015) identifies in Stiegler the same kind of failing that Stiegler identified in Rousseau: the originary technicity of Stiegler's human relies on humans already having mental representations that form the basis of technical plans. In contrast, Tomlinson argues for tool use that precedes such capacity for planning and instead arises from a "self-organizing complexity" between hominins and environment (87).
4. It is worth noting that another shift in Patel's more recent work has been toward discoveries of musical capacities that are not unique to humans (see Patel et al. 2009 and Keehn, Iversen, Schulz, and Patel 2019).

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