



Expansionism, Extremism, and Exceptionalism in Life

Boltzmann Brains as a Transdisciplinary Methodology

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Abstract This article explores how taking physical cosmology and the entities that populate its fringes on their own terms might prompt anthropology to rethink what and how it thinks of life. Physical cosmologists work with inanimate matter that lies at the frontier of existential possibility, positing scales and concepts that seem to negate commonsense notions of life and nonlife. Although a common reaction in anthropology when faced with such infinite, nonhuman, and abstract landscapes is to try to crowbar “everyday life” back in, we argue that conceptual space needs to be made for another style of engagement between anthropology and physical cosmology. Taking the Boltzmann Brain as an example of life not only beyond the human but also beyond life as we know it, we start to flesh out a different sort of speculative, transdisciplinary endeavor.

Keywords cosmology, life, Boltzmann Brains, limits, speculation

When trying to trace the recent interest in “life” as a subject of anthropological study, it is striking to what extent the idea shape-shifts into a proliferation of different forms and agendas. Life, in a multitude of guises, is increasingly being extended to a vast array of nonhumans, not just in anthropological descriptions but across the social sciences and humanities. In some cases, a revitalized look at what constitutes life has meant a challenge being put to human exceptionalism, as Donna Haraway has argued for in *When Species Meet* (2008), a call that was taken up by proponents of the “multispecies” turn in anthropology, who observe that “animals, plants, fungi, and microbes once confined in anthropological accounts to the realm of zoe, or “bare life”—that which is killable—have started to appear alongside humans in the realm of bios, with

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legibly biographical and political lives.”¹ In other cases, ambitious and overarching theories of life have been developed, as with Tim Ingold and Gísli Pálsson’s theory of biosocial becomings,² which aims to break down the encompassing dualism of the biological and cultural as defining the limits of life in favor of a more processual, emergent, and relational understanding that will unite the natural and social sciences; or as Eduardo Kohn argues for in his recent book *How Forests Think*, in which he urges anthropology to put forward “general claims” in order to be “true to life,”³ positing humans as continuous with and emergent from a “broader living semiotic realm,”⁴ in which all living beings are selves.

This generosity of spirit has even been extended to inorganic and inanimate objects. Anthropological descriptions of non-Western cultures have documented how what we in Euro-America might think of as asocial and insensate objects often have busy social lives or express vital forces.⁵ But scholars in science and technology studies (STS) and philosophy have also made the case for understanding the inanimate things that populate Western sociomaterial imaginaries as more than just objects caught in a reductive subject/object binary. In these cases, STS scholars like Bruno Latour have argued for a complete reworking of the idea of what it means to act, maintaining that anything that has effects can act, and famously calling for the inclusion of all manner of sundry objects as active agents in the ongoing elaboration of social life.⁶ In a similar vein, philosopher Jane Bennett has proposed the notion of “thing-power” to refer to the “vitality, willfulness and recalcitrance possessed by nonhuman entities and forces”⁷—entities as apparently mundane as a bottle cap, or a stick of wood. This new materialism can therefore be thought of as contributing to the elaboration of a more inclusive notion of what constitutes life itself, and what gets to be counted as alive. Taken as a whole, within this literature life is diffracted through a multitude of concepts and approaches—social, agential, future-oriented, nonrepresentational, reflexive, relational, imagined, embodied. Despite their provenance in what might be understood as a common sociopolitical project—the extension of life beyond the human—each of these interventions proposes a particular shape for what it means to be alive.

In this article, we want to inquire into the limits of this expansion of life beyond the human. As such, what interests us is not any one particular definition of life that emerges from these interventions—whether the focus is agency, vitality, consciousness, sociality, and so forth—so much as the commitment to the possibility for the endless

1. Kirksey and Helmreich, “Emergence of Multispecies Ethnography.”

2. Ingold, “Prospect.”

3. Kohn, *How Forests Think*, 10.

4. *Ibid.*, 16.

5. Mauss, *The Gift*; Gell, *Art and Agency*; Henare, Holbraad, and Wastell, “Introduction: Thinking through Things.”

6. Latour, *We Have Never Been Modern*.

7. Bennett, “Force of Things,” 347.

inclusion of entities that have previously been excluded. In other words, we are not interested in working out exactly what life is, so much as in trying to think about what happens at the limits of our capacity to constantly redefine who or what gets to have it.

This capacity for redefinition, we argue, lies at the heart of many current projects to involve more and more entities in human lifeworlds; and it often involves a recursive movement, such that it is not only the entities to be included that are necessarily redefined, but the contours of the human lifeworlds they are to be included in that are transformed as well. Thus, in Latour's actor-network theory (ANT), we see a redefinition of what it means to "act"; it is through rethinking action and agency as a capacity of what we might have thought of as objects that Latour can make claims as to the radical symmetry between humans and nonhumans that underpins his approach.⁸ Kohn asks what would happen if we redefine what it means to "think" so as to include the world beyond humans as part of the same web of semiotic relations, on the basis that all "life thinks; thoughts are alive."⁹ In a similar vein, Anna Tsing asks what would happen if we reassess what "sociality" means, in order to include more-than-human socialities in our definition of what it means to be social.¹⁰ As Tsing points out, "Anthropologists study things as gifts, as commodities, as signs, and as tools. But all of these are human projects for being with things. None allow things to have their own socialities. In contrast, in the approach I am suggesting, humans would have to join more-than-human socialities. We might not always be in charge. We might get to know other-than-human worlds in which we participate, but in which we don't make the rules."¹¹ Thinking of mushrooms as social, and paying attention to how they might be so in ways different to humans, requires that we change our ideas of sociality to such an extent that we have to consider ourselves in a new light. Sociality is extended to nonhumans, but is also itself potentially redefined in the process. By including entities normally excluded from our configurations of agential life, social life, or subjective life, we not only engage in a form of ethical action, but we are also asked by these authors to radically rethink what we take to be human life in the first place.

The descriptive and political force of such moves is undeniable, not least because such arguments are based upon overcoming different sorts of reductive binary—subject/object; human/nonhuman; animate/inanimate; life/not-life. But in these contexts of redefinition, there is one binary that seems to underwrite them all—included/excluded. It is this binary, in fact, which lends these moves both their political and descriptive power: to endlessly include more and more entities, bringing them in from the cold, so to speak. And in fact, the more excluded they have been, the more powerful the claim for inclusion is. Nevertheless, we wonder, borrowing a critique that Nick Lee

8. Latour, *Reassembling the Social*.

9. Kohn, *How Forests Think*, 16.

10. Tsing, "More-than-Human Sociality."

11. *Ibid.*, 33.

and Steve Brown have made of ANT, whether such unrelenting inclusion, and indeed redefinition, “is so liberal and democratic that it has no Other.”¹² That is to say, what or where are the limits of these expansive inclusionary tactics?

Bearing this question in mind, we, as an anthropologist and a physical cosmologist working together, would like to explore the limits of exactly such inclusionary agendas by introducing some particularly extreme examples of life from the further reaches of current cosmological speculation: Boltzmann Brains. We want to see how Boltzmann Brains might force us to think about the explicit and implicit choices we make when redefining the boundaries of life. Extremes are particularly interesting examples to take because they need not act as signifiers of simple boundaries. In fact, as David Valentine, Valerie Olsen, and Debora Battaglia argue, “the value of the extreme is to enable us to ethnographically examine the social fields of extremity as extensions of human histories and socialities without assuming that we know what will result from them.”¹³ As we shall see, Boltzmann Brains seem completely outside our current understanding of life. However, one of the most intriguing and challenging aspects of Boltzmann Brains is not that they are utterly unlike life as we know it. It is rather that they are *both* extremely unlike, and extremely like, life as we know it.

Boltzmann Brains as Extremes

Anthropologists have for some time now been turning an ethnographic focus onto scientific disciplines in order to investigate life. Perhaps unsurprisingly, this has yielded a wealth of different ways in which life is defined and used to frame different social and political agendas. As Stefan Helmreich has demonstrated, even in the biological sciences alone, life is not understood in one way; in his study of life within what he calls three “limit biologies,” Helmreich strives to trace out the specific and defining contours of exactly what versions of life are being forged in each case.¹⁴ In artificial life, we meet a form of life that is abstract and concerned with form; where bodies are information patterns.¹⁵ In the microbiology of extremophiles, Helmreich shows us a “realm of extreme metabolisms, jumbled genealogies, and shifting scales,”¹⁶ in which life cannot be shorn from its substrate but is nevertheless plastic and always working at its own limits. In astrobiology, we meet scientists looking for traces and shadows of life as we know it, who push at the limits of their knowledge; in looking for life beyond they also inadvertently make the cosmos “ecological,” endlessly resuscitating the vision of life as an “untapped biological resource.”¹⁷ Helmreich’s work makes abundantly clear not only that science is full of different life forms, but also that these life forms come to matter

12. Lee and Brown, “Otherness and the Actor Network,” 774.

13. Valentine, Olsen, and Battaglia, “Extreme,” 1012.

14. Helmreich, *Sounding the Limits of Life*.

15. *Ibid.*, 6.

16. *Ibid.*, 12.

17. *Ibid.*, 15.

in particular ways in influencing how life is configured—or conformed to—beyond the confines of each discipline.

Physical cosmology, however, is not the most obvious place to look for examples of life forms, and it certainly does not consider itself to be a discipline that studies life. It trucks in ideas of infinite time and infinite space, and works on scales that are very far from the sorts of lifeworlds that we imagine for ourselves as humans. So this is not the most obvious place to turn to when trying to think about the issues that concern us in this article. Furthermore, we will be venturing to the outermost limits of these extreme scales—limits so far in the future that it requires willful acts of speculation on behalf of cosmologists in order to talk and think about them. However, it is exactly this speculative capacity of physical cosmology that is going to prove important for our discussion.

Cosmologists have, through the development of new observational tools and many decades of persistent observation, converged on a standard model of the universe, composed of ordinary (baryonic) matter, dark matter (which does not interact with light), radiation, and dark energy (a smooth background field filling all space). The big bang, fourteen billion years ago, is our compact, low-entropy, high-temperature initial state; since then the universe has expanded and cooled, allowing for the formation of galaxies, stars, and planets like our Earth. As the universe expands, the density of radiation and matter, both ordinary and dark, decreases. Dark energy, on the other hand, is an intrinsic property of space, meaning that as the universe enlarges, the amount of dark energy increases (the spatial density of dark energy remains constant throughout space), as does the fraction of the total energy density coming from dark energy. The future of our universe, according to our current standard model, is therefore clear: the role of matter and radiation becomes increasingly insignificant. After the last stars burn out, planets disintegrate, and even isolated atoms decay into nothing, space will be a featureless void, bathed in the constant background of dark energy—and this state will persist into an infinite future.

If we take this scenario seriously, then an odd feature emerges. In our distant future, deep in the era of dark-energy domination, space is filled by a constant background energy field in a state of thermal equilibrium. Like any energy field, it will experience random fluctuations, whose properties are quite well understood. These energy fluctuations will manifest in different ways; sometimes they might appear as a simple subatomic particle, say, an electron, or they could appear as something more complex.¹⁸ It is more probable that a fluctuation will take a simple form than a more complex one, but the probability of even the most complex fluctuation is still finite. As such it is perfectly possible that a fluctuation with all the complexity and attributes of a thinking consciousness will occur. Cosmologists call these thinking fluctuations “Boltzmann Brains.”¹⁹

18. $E=mc^2$, so matter and energy are interchangeable.

19. Dyson, Kleban, and Susskind, “Disturbing Implications of a Cosmological Constant”; Rees, *Before the Beginning*; Albrecht and Sorbo, “Can the Universe Afford Inflation?”

These Boltzmann Brains have a very small probability of occurring. Indeed, it is vanishingly unlikely that even one has existed in the whole history of the universe up to the present moment. But unlike say, human beings, they remain just as probable in the future, when the universe is empty of all but dark energy, as they are today. Cosmology has no reason to believe that the future universe will not continue to exist forever in this empty, dark, energy-dominated form. Forever is a very long time, long enough for even the most improbable fluctuations to occur; indeed, arbitrarily complex fluctuations must occur and recur infinitely over infinite time. Thus, it is expected that Boltzmann Brains will exist during the future course of our universe's history, and in fact, over the course of an infinite future, you can expect to see an infinite number of Boltzmann Brains.

Thus observers like humans, who can only exist for a comparatively short period in the history of the universe, will be radically outnumbered by these Boltzmann Brains. This is key to the scandalous nature of Boltzmann Brains for cosmologists, as it means they upset the statistical validity of much cosmological inference, which is premised upon humans being "ordinary observers." Cosmologists, if they consider Boltzmann Brains at all, therefore see them as a source of a paradox about our ability to make inferences from observations. However, this is not the aspect of Boltzmann Brains that we want to concentrate on at present, though we will comment more on their position within the field of cosmology later. In the first instance, we want rather to consider what happens if we take these Boltzmann Brains seriously, on their own terms. In doing so, we recognize that we are performing a thought experiment of sorts, as no living human will ever meet a Boltzmann Brain. Nevertheless, when we do take them on their own terms, we find that Boltzmann Brains pose some interesting challenges for thinking about life, and particularly thinking about what gets to be included in the various manifestations of life with which we started.

One consequence of our shift of focus away from Boltzmann Brains as a type of cosmic observer, toward the implications they may hold for conceptions of life, is that we are not particularly interested in Boltzmann Brains as such. When a cosmologist figures a Boltzmann Brain, they are not usually thinking of a fluctuation that resembles a human, or even a disembodied human brain (though these do come up). Rather they refer to any entity endowed with the ability to *observe* and *think*. As simple fluctuations are statistically more probable than more complex ones, the majority of these Boltzmann Brains will be the simplest congregation of components consistent with *thinking* or *observing*, however we choose to define those activities.²⁰ So, while we will retain the term *Boltzmann Brain* throughout the rest of this article, we are really considering a more general class of probabilistic fluctuation.

20. The Boltzmann Brain paradox does not, for cosmologists, depend on the details of how you define these activities. However, some cosmologists have tried to escape the paradox by asserting that Boltzmann Brains are incapable of anything that could be defined as observing.

Boltzmann Brains will exhibit a literally infinite variety of forms. Nevertheless, they have one property that is so unlike anything that we might think of as life, that it must call into question the idea that Boltzmann Brains are alive at all. Humans, and the rest of our observable universe, are what we can call thermodynamically ordered entities. We have come to exist after a series of cause-and-effect events, playing out with ever-increasing entropy, from the big bang to today. This includes, but is not limited to, the formation of atoms, the accretion of galaxies, the birth of stars and planets, and a long chain of biological evolution. Boltzmann Brains however are thermodynamically disordered entities, arising not out of some complex history of cause and effect but rather from random noise in the dark-energy bath. This makes them profoundly unlike “life as we know it.”

To give a few examples: physicists’ best guess at why humans experience the flow of time from future to past is because that is the direction of ever-increasing entropy. This is called the “thermodynamic arrow of time.” But for a Boltzmann Brain, both the past and future have higher entropy than the present, and so the arrow is broken. It is unlikely a Boltzmann Brain could experience the passage of time as we know it. Beyond that, Boltzmann Brains are entities which are fundamentally probabilistic in nature. Take a Boltzmann Brain in some given state, and further assume it survives until the next state, whether that is one Planck time later or one million years—it is *far* more probable that the configuration of the Boltzmann Brain in the second state will be only randomly related to the first state, rather than bear any causal connection through physical action of any kind. This profoundly random, or disordered, nature has led to Boltzmann Brains being called “freaky” observers;²¹ others have called them “mad” or “senile.”²² Because their state at any moment—including any “thoughts” the Boltzmann Brain might be having—is likely to be only randomly connected to their previous state, they call into question attributes taken as natural in complex, conscious entities: observation, reaction, reflex, volition, coherent consecutive thoughts—all of these are perhaps the exception in a universe of freaks.

On the one hand, then, Boltzmann Brains are unlike anything we might consider as alive, not because they fulfill the negative criteria of being not alive as such but because they simply bypass or short-circuit that binary altogether. It is not just that they do not resemble life as we know it; in fact, their inherently probabilistic nature means that they are so freakily different from *everything else* that we might be inclined to assign life to—from bottle tops to orangutans—that it is difficult to work out where they might fit in any schema at all. From this perspective, anthropology might be moved to exclude them from *any* definition of life, be it social, agential, conscious, semiotic, or whatever.

On the other hand, however, an infinite number of Boltzmann Brains will display characteristics that make it very easy to include them in all anthropological or social scientific redefinitions of life. Some Boltzmann Brains will look exactly like humans,

21. Vilenkin, “Freak Observers and the Measure of the Multiverse.”

22. Page, “Is Our Universe Decaying at an Astronomical Rate?”

just as other fluctuations will look like toasters or the complete works of Shakespeare. Even though these Boltzmann Brains will be more rare than any simpler collection of particles, the infinite time frame of the future universe means they will still exist in infinite number. This infinity of Boltzmann Brains would, like humans or other animate life forms that we know, be biologically active, composed of cells, supported by a circulatory system, feeling through a nervous system. They would, like us, be vital and mobile. They could express thought and emotion through physical or vocal gestures, and a sufficiently complex fluctuation could present a (hypothetical) observer with a Boltzmann Brain that looked to any human like it was interacting, socializing, fully *living* together in a world more or less like our own.

If this were to occur—which it will an infinite number of times—it would be because these characteristics that we associate with life have emerged in Boltzmann Brains randomly, through chance. The probabilistic nature of Boltzmann Brains means in fact that, at the far future of the universe, after the heat death and the disintegration of all the structure that populates our night skies today, we are confronted with an infinite array of entities who can be figured as *arbitrarily* alive, however we like to define that. An infinite number of Boltzmann Brains, of at least some kind, will always cleave indistinguishably closely to the appearance of humans, mushrooms, dogs, or any other entity that we have no problem assigning life to.

Boltzmann Brains therefore offer a particular sort of extreme example. They emerge from our standard cosmological model, taken to the extremes of speculation; they exist in the extreme future, in extreme numbers; infinitely many will look exactly like ourselves, while infinitely many more will look extremely different; but their probabilistic nature makes them so extremely different from our conception of life in a way that no fungus, stone, or railway timetable could ever aspire to. Does this *extreme* extreme simply invite definitions of life to transgress a new horizon, or does it destabilize and limit such an expansionary project?

The inclusionary agendas of many anthropological and STS approaches, as we mentioned earlier, hinge on a constant process of redefinition. We can either extend certain characteristics of life such as agency, vitality, sociality, and so on to other entities, thus redefining them in order to include them; or, in a more complex move, we can ask how these very categories, by being extended to these entities, might be themselves redefined so as to be more inclusive.

Trying to include Boltzmann Brains in such a dynamic, however, causes some problems. On the one hand, we might try to consider them as agential, social, coherent, or vital—as alive—given that there will always be an infinite number of Boltzmann Brains that would be indistinguishable from any entity that might fit any criteria of life we might choose. But the highly probabilistic nature of Boltzmann Brains, their freakiness, as it were, would stretch any of these terms of inclusion so significantly out of shape they would no longer be recognizable. Or, if we did not redefine the terms to accommodate Boltzmann Brains, but tried to redefine Boltzmann Brains instead to accommodate the terms, we would be faced with redefining them in turn beyond recognition. The

redefinition is too extreme, in both directions, to seem plausible. Including some Boltzmann Brains in our conception of life, however demarcated, is unsettling because they have achieved the relevant characteristics by chance, not in the incremental, stable way of their thermodynamically ordered counterparts.

If, on the other hand, on these grounds we were to exclude all Boltzmann Brains from our inclusionary agenda, no matter their individual characteristics, we are confronted with excluding an infinite number of entities that would be to all intents and purposes as close to human, animate, organic, vital, social life as it is possible to be. An infinite number of Boltzmann Brains demand inclusion within any definition of life we propose, while at the same time offering resistance to that very inclusion because of their origin in random chance. An infinite number of Boltzmann Brains will always be both outside and inside any particular binary of inclusion/exclusion that we might choose. Whether we consider this to be unsettling, or indeed to short-circuit the whole inclusion/exclusion dynamic, rather depends on the status we give to Boltzmann Brains as entities to think with.

Boltzmann Brains as Cosmological Outsiders

Now, of course, as we have mentioned, Boltzmann Brains are an extreme; and as such it would be easy to discount them as nothing more than a very speculative thought experiment. Why should we care about the challenges that they might pose for inclusionary and exclusionary dynamics, or even life itself, when there is no chance of ever encountering them? What makes them, in this sense, different from any other sort of fictional entities? And moreover, by taking them seriously, are we not simply taking scientific realities as truth?

Regarding the last point, we recognize that to argue that Boltzmann Brains must be taken on their own terms, or taken seriously in order to challenge current ideas about inclusion and exclusion, contains within it an ontological sleight of hand. For decades STS scholarship has taken pains to demonstrate how scientific knowledge, far from having direct access to the world in-itself, is no less mediated, situated, politicized, and contingent than any other kind of knowledge; and thus should have no a priori claim to truth. However, what is particularly interesting about these protestations—at least in the case of the first two—is that they are very like the forms of resistance to Boltzmann Brains that one encounters *within* the physical cosmology community. Boltzmann Brains are not just problematic for anthropology, but for cosmology as well. What this means is that Boltzmann Brains are not exactly cosmological or scientific knowledge-framed-as-truth; for cosmologists, they are a form of very uncomfortable speculation.

It is important to remember that, for most of the twentieth century, cosmology was a barely reputable branch of astronomy. Cosmologists could not perform experiments and had very little data to work with. Theories were often dismissed as groundless speculations. The last few decades however have changed that. There is now a great deal of data from telescopes and satellites which, combined with sophisticated statistical methods, allows cosmologists to make precise statements about the universe.

This notwithstanding, the role of speculation seems to remain more pronounced in cosmology (and, to an extent, astronomy generally) than in other branches of physics. Cosmologists cannot manipulate their objects of study, and cosmology often involves conceptualizations of distances and times—the deep past and future—not only beyond human experience but far beyond our wildest technological frontiers or even the timeframes encoded in the ecology and geology of our planet. As a result, cosmology has produced a menagerie of entities that, to the general public, seem closer to science fiction than what might be conventionally understood as serious scientific discourse: string theory, dark matter, dark energy, black holes, not to mention Boltzmann Brains themselves.

For most cosmologists, however, there is in fact a great deal of difference between, for example, dark matter, supported by multiple strands of observational evidence, and string theory, which belongs to a more speculative realm without existing observational confirmation. Indeed some have suggested that string theory is beyond scientific verification entirely and should not be the recipient of so much research time.²³ Boltzmann Brains, for their part, occupy an even more fringe position in contemporary cosmology than string theory. Though both are highly speculative, insofar as they rely on speculative hypotheses derived from our model of the universe rather than empirical observation, Boltzmann Brains are much more peripheral, and more challenging.

Boltzmann Brains are perplexing for cosmologists because, as we mentioned earlier, they cause a logical paradox, which undermines the philosophical foundations that let cosmologists make what they consider to be grounded speculations about the universe. Modern Western cosmology, since the seventeenth century, has been a history of Copernican displacements. The Sun does not go around Earth. The solar system is only one of many in an undistinguished spiral arm of an ordinary galaxy, one of billions, nowhere special in an enormous universe. In one sense, this profound displacement of humanity from the center of things has been the saving grace for cosmology as a science. It can draw on humans' very mediocrity to posit them as typical observers of a homogeneous and isotropic universe. Statistically this allows cosmology to make statements based on observations, knowing they would look similar from any vantage point. This lets cosmologists draw conclusions with some certainty, even though they cannot make repeated experiments as most other natural scientists do.

Boltzmann Brains threaten this. They represent a final, very strange displacement. Perhaps humans (and other beings with "normal" entropic histories) are not typical observers at all, being wildly outnumbered by future Boltzmann Brains. Humans are once again atypical, but they have not been re-enthroned at the center of creation; instead they are now so freakish and irrelevant that cosmology cannot, with any certainty, make solid statements about the universe based on their observations. When the lifespan of the universe is your frame, freaky observers, or Boltzmann Brains, are much more common than any other form of baryonic matter, such as humans, rocks, or even

23. Smolin, *Trouble with Physics*.

planets. So from the perspective of cosmology, the problem posed by Boltzmann Brains is not so much a challenge put to human exceptionalism, but to human mediocrity.

This paradox makes cosmologists uneasy with Boltzmann Brains, meaning they are often ignored on the assumption that there simply must be some reason why they will not exist in practice. There are various ways that cosmologists attempt to “save appearances” by excluding Boltzmann Brains, from asserting that some fundamental property of quantum mechanics²⁴ means they never arise to inferring a finite lifetime for the universe²⁵ such that Boltzmann Brains never have time to outnumber ordinary observers. This exclusion also plays out in what might be thought of as Boltzmann Brain’s patchy and troubled circulation within the institutions of cosmology. You cannot apply for a research grant to get telescope time to observe a Boltzmann Brain; no funding body would provide resources to seriously investigate them. Nor are they quantifiable unknowns like dark energy, which can be studied if you measure a few hundred million galaxies, observe how they move with time, compare this with current theory, and then speculate about the need for a new form of energy. Boltzmann Brains are mental constructs that emerge from quantitative observations but are, at the same time, untouchable by those same observations, lying as they do in our ultra-distant future. This elicits a certain hostility from some modern cosmologists who are keen to lose their image of woolly speculators in favor of the hard-headed observational approach that drives much of the rest of contemporary physics.

Boltzmann Brains, we argue, therefore occupy something of a privileged position.²⁶ They not only have the capacity to disrupt and destabilize anthropological notions of life, sociality, agency, and so on; in a very different way, they are also weird and unsettling for cosmology’s statistical foundations and for cosmologists as a group engaged in a social enterprise. Even if we are, in this article, taking Boltzmann Brains on cosmology’s terms, we also want to be mindful of the particular ways in which those terms are unstable and potentially risky; that is to say, we want to be mindful of how Boltzmann Brains do not sit easily within them. We are not dealing with scientific knowledge as such, but with the fringes of scientific speculation. So although in one sense, we want to use the Boltzmann Brains of cosmology to disrupt anthropological ideas, in another we want to retain their uneasy relationship to cosmology to disrupt the way in which anthropology might relate to such cosmological knowledge.²⁷ As such, taking

24. Boddy, Carroll, and Pollack, “Why Boltzmann Brains Don’t Fluctuate into Existence from the De Sitter Vacuum.”

25. Page, “Is Our Universe Likely to Decay within 20 Billion Years?”

26. We’d like to thank Martin Holbradd for suggesting we explore this.

27. It’s worth remarking here that other recent examples of social scientific engagements with physics are much more comforting than engaging with Boltzmann Brains. For example, Karen Barad’s study of the life and work of Niels Bohr resulted in her elaborating a theory she named “agential realism,” which dovetails with her description of Bohr’s own theories of complementarity, and with more general non-Cartesian posthumanist ideas. It is hard to imagine Boltzmann Brains ever providing such neat theoretical packages—they are quite literally only ever going to, conceptually speaking, freak us out. Barad, *Meeting the Universe Half-Way*.

Boltzmann Brains on their own terms does not mean parroting scientific models as truth, but paying attention to the ways in which Boltzmann Brains inhabit a space that is neither quite inside nor outside both anthropological theorizing about life and cosmological theorizing about the universe.

Boltzmann Brains as Transdisciplinary Methodology

In the final part of the article, we want to suggest that Boltzmann Brains might be used as a form of transdisciplinary methodology. We suggest that speculative or extreme entities like Boltzmann Brains are liberating for transdisciplinary endeavor because they are uncomfortable in both home disciplines, in this case physical cosmology and anthropology. Rather than trying to transfer wholesale the practices or stock phenomenon—whose jagged contours and rough edges have been worn smooth by familiarity—of one discipline onto the terrain of another, we have fixed our sights on a speculative phenomenon that has not, at least yet, been comfortably incorporated into “business as usual” cosmology. Nor, as we have shown, is it easily incorporated into anthropological dynamics, such as those driven by a focus on relating to “more-than-human” life. This placement, both inside and outside both disciplines, means we can attempt to produce a situation of *shared perplexity* across disciplinary boundaries, rather than shared certainty.

We will thus turn here from a discussion of the weird, freaky, and challenging characteristics of Boltzmann Brains for both anthropology and cosmology separately, to the relationship itself between anthropology and the natural sciences. We want to draw attention to the extent to which the ever-expanding anthropological repertoire of liveliness, life forms, and social worlds, occurs simultaneously with a call for a different sort of—less antagonistic, more open—engagement with the natural sciences. This marks a shift from a deconstructionist challenge to scientific means of knowledge production to a more open attempt to embrace scientific method and knowledge. But this, again, involves a process of redefinition—this time of science itself—that we would like to interrogate.

It is of note that the recent retheorizations of life have their roots more or less firmly planted in critiques of Euro-American scientific practice—which is often understood as having at its core a commitment to Cartesianism. Cartesianism has become shorthand for the paradigm according to which the domains of mind and body, reality and representation, and nature and culture are opposed, or in a dialectical relationship to each other. The critique claims that this framing of the world—and others considered to embody a similar modernist or enlightenment legacy such as Darwinism or Newtonian mechanics—are woefully inadequate when it comes to trying to understand not only other forms of life but also alternative ways in which life is lived, in which these domains are hybridized, entangled, or otherwise coproduced. The main perpetrator of the Cartesian paradigm is often, in these literatures, taken to be Western science that, in Latour’s terms, seeks to purify the world into the distinct realms of

“the natural” and “the social.”²⁸ Many of the accusations leveled at such reductive metaphysics have come from anthropologists working with indigenous peoples,²⁹ but it has become commonplace to draw descriptions of alternative visions of life using natural or Western science as a general foil. Tim Ingold goes so far as to argue that Western science is totally detached from life altogether:

The conditions that enable scientists to *know*, at least according to official protocols, are such as to make it impossible for scientists to *be* in the very world of which they seek knowledge. Yet all science depends on observation, and all observation depends on participation—that is, on a close coupling, in perception and action, between the observer and those aspects of the world that are the focus of attention. If science is to be a coherent knowledge practice, it must be rebuilt on the foundation of openness rather than closure, engagement rather than detachment. And this means regaining the sense of astonishment that is so conspicuous by its absence from contemporary scientific work. Knowing must be reconnected with being, epistemology with ontology, thought with life.³⁰

Critiques of science as devoid of liveliness or “troping”³¹ also sustain a particular understanding of scientific practice, as based on objectivity. Objectivity is often described as the exclusion of the self—the subject—from the world being studied, or at least the claim to be able to do so.³² A facet of this exclusion is that scientists have “to eliminate the mediating presence of the observer”³³ and, as such, to claim to speak from what has been called “the view from nowhere”³⁴; or, in Donna Haraway’s terms, to be able to perform “the god trick of seeing everything from nowhere.”³⁵ There are other ramifications of this exclusion: also implied is the more restricted sense in which scientific practice is understood to prohibit any sort of self-expression or creativity, as anthropologist James Leach explores;³⁶ or more broadly, the way in which science, alongside other realist methodologies, seems to miss out on the “mess,” as John Law puts it, of the world.³⁷ Objectivity, so the broad argument goes, takes all the life out of life (a result often

28. Latour, *We Have Never Been Modern*.

29. See, e.g., Viveiros de Castro, “Exchanging Perspectives.”

30. Ingold, *Being Alive*, 75.

31. Haraway, *Modest_Witness*, 134.

32. Although historian of science Lorraine Daston suggests that “objectivity” is a rather confused notion, referring to “metaphysics, methods and morals,” concerns that have varied enormously through history and vary even in present usage: “We slide effortlessly from statements about the ‘objective truth’ of a scientific claim, to those about the ‘objective procedures’ that guarantee a finding, to those about the ‘objective manner’ that qualifies a researcher.” Daston, “Objectivity and Escape from Perspective,” 597.

33. Daston and Galison, “Image of Objectivity,” 82.

34. Nagel, *View from Nowhere*.

35. Haraway, “Situated Knowledges,” 581.

36. Leach, “Self of the Scientist.”

37. Law, “Making a Mess with Method.”

ascribed to the reliance of the natural sciences on quantitative methodologies³⁸), and anthropology's task then becomes putting the life back in.

However, although many of the anthropological efforts to expand life beyond conventional ontological borders thus have their roots in critiques of mechanistic and objective scientific practices, they have also led back round to a reappraisal of science itself. This was perhaps inevitable, as many of these critiques were premised on retroactively transforming the target of the critique, namely, scientific thought and practice. If, as Latour puts it, we moderns can now see that we have never been modern, likewise, science has never in fact been objective (at least not in the way we/they thought it was).³⁹ There is now a body of work in anthropology and STS that not only focuses on the forms of liveliness that constitute scientific practice but also pays close ethnographic attention to the ways in which different scientific disciplines shape life as symbolically and materially knowable. Thus, Natasha Myers's recent ethnographic study of protein crystallographers⁴⁰ draws attention to the embodied ways in which these scientists come to "know" the proteins they are making tangible. Influenced by both phenomenological theory and her work as a dancer and indeed a molecular biologist, her study concentrates on the bodily choreographies by which these scientists render molecular life knowable as a material entity within 3-D models. Her intent in so doing is to challenge "conventional assumptions about the practices of objectivity"⁴¹ and thus "change what we think science is and could become"⁴² by eliciting the "moments when these practitioners do not abide by the de-animated, mechanistic theories of life they are supposed to avow."⁴³

By drawing attention to the embodied ways in which scientific objectivity operates, Myers's study hopes to elicit a different vision of science, one characterized in fact by its putative opposite—not objective, mechanistic, and detached observation but bodily, situated engagement.⁴⁴ As such, it could be argued that her work to a certain extent draws on older traditions in STS that have always argued for an understanding of science that gets to grips with what might be thought of as its hidden underbelly—the

38. Although see Blok and Pedersen, "Complementary Social Science?"

39. Haraway, "Situated Knowledges."

40. Myers, *Rendering Life Molecular*.

41. *Ibid.*, 5.

42. *Ibid.*, 8.

43. *Ibid.*, 5.

44. Although here see Myers and Dumits's concept of "mid-embodiment," which complicates the bodiliness of embodiment. They describe it thus: "these researchers spend significant portions of their time figuring out *what it might be possible to know* in the context of their experiment. What we offer, then, is an anthropological phenomenology of those sometimes fleeting, sometimes prolonged moments that arise in the middle, mid-thought or mid-gesture. This article thus tracks this constantly morphing tangle of bodies, instruments and objects that we call the *mid-embodiments of experimental life*." We are also in this article interested in forging new sorts of speculative spaces, albeit ones with very different coordinates from this. Myers and Dumit, "Haptic Creativity."

hybridity, mediation, mess, and indeed liveliness of what it is to do science.⁴⁵ So from one perspective, Myers's work, and other work like it, follows partly in the tradition of STS scholarship that has sought to show not only how science is thoroughly social but also how it is also lively and creative.⁴⁶ Thus Myers and Joe Dumit have coined the term "haptic creativity,"⁴⁷ to account for the "improvisational, exploratory,"⁴⁸ and "affectively and kinaesthetically engaged"⁴⁹ forms of scientific knowing and doing they come across in their work.

There is an obvious resonance here between the way in which science is being redefined in order to be included in anthropological projects and the inclusionary dynamic we pointed out earlier on in the article, when it came to drawing other entities into our expanded definitions of life, sociality, vitality, and so on. Here it is science that is being refashioned, but the analytical move is very similar: redefine science in order to "include" it in anthropology. But anthropology is also being transformed in this process. What is striking about the work of Myers, Dumit, and their colleagues is the explicit intent not to deconstruct science but to forge a new and different relationship with the natural sciences through this redefinition. Myers and Dumit tell us how they work alongside the scientists they study, "working with and within research groups . . . at the place where our research problems and those of the scientists meet."⁵⁰ Thus it is not only science that is being redefined but also anthropology's relationship to it and therefore, one might argue, anthropology itself.

We are extremely inspired by such moves, but we want to build on these insights by pointing in a slightly different direction. We argued earlier that Boltzmann Brains are difficult for anthropological or STS expansionary visions of life because they are extreme in a very particular way, by being both extremely inside and extremely outside life as we know it; we then pointed to the strange relationship that Boltzmann Brains also have with cosmology: both included and excluded from cosmological knowledge. Boltzmann Brains, then, are uncomfortable in different ways for both anthropology and cosmology.

Following on from this, the first point to make then about Boltzmann Brains is that they seem to be interesting entities for anthropology and cosmology to investigate together—which is what we have tried to do in this article. Freaky or uncanny entities from the edges of formal scientific narratives populate the worlds of science fiction novels, and have inspired potent social and political movements,⁵¹ as well as anthropological theorizations—most notably perhaps in the monstrous shape of Haraway's

45. Latour, *Science in Action*.

46. See, e.g., Hans-Jörg Rheinberger, *Epistemology of the Concrete*.

47. Myers and Dumit, "Haptic Creativity."

48. *Ibid.*, 244.

49. *Ibid.*, 253.

50. *Ibid.*, 258.

51. See, e.g., Farman, "Re-enchantment Cosmologies."

cyborg.⁵² Boltzmann Brains do seem to linger somewhere in between reality and imagination. They are on the one hand a product of valid scientific speculation that do not require any new physics, as they simply take what cosmology knows to its logical conclusion. But they are also on the other hand at the very fringes of such a speculative knowledge space, and the source of a paradox. As shared objects of enquiry, we argue, they seem to offer the potential for a different sort of relation to emerge between the natural and the social sciences—or more specifically, anthropology and cosmology—which are based on shared perplexity rather than shared knowledge.⁵³ This form of sharing is not so much a question of something encompassing or singular but rather is constituted by bringing different forms of perplexity together that have something to say to each other. The point is not to work out how to include or exclude Boltzmann Brains in either an anthropological or cosmological approach, but how to capitalize on how they make each discipline uncomfortable.

As far as conceptions of life are concerned, Boltzmann Brains unsettle any inclusion/exclusion binary, no matter its location on the gradient of increasingly inclusionary approaches to life. We do not aim to discredit such approaches, which are clearly productive in many ways. Rather we hope that the new considerations and arguments generated by thinking about Boltzmann Brains from an anthropological perspective and, more generally, a perspective concerned with Boltzmann Brains as more than just the source of a particular cosmological paradox, can energize discussions around the definition of life. In part, we think Boltzmann Brains are well placed to do this because of their unsettling insider/outsider status in *both* physical cosmology and the anthropology of life. This makes for a transdisciplinary encounter that hinges on the potential to share uncertainties and puzzlement, which might stretch both disciplines out of shape simultaneously, but differently. We hope that the particular coordinates of this encounter, built on a phenomenon causing mutual discomfort and positioned somewhere not quite inside either discipline, are replicable and might act as a pointer toward developing such interactions between the social and physical sciences further.

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52. Haraway, *Simians, Cyborgs, and Women*.

53. Stengers, *Invention of Modern Science*, 66.

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References

- Albrecht, Andreas, and Lorenzo Sorbo. “Can the Universe Afford Inflation?” *Physics Review D* 70, no. 063528 (2004).
- Barad, Karen. *Meeting the Universe Half-Way: Quantum Physics and the Entanglement of Matter and Meaning*. Durham, NC: Duke University Press, 2007.
- Bennett, Jane. “The Force of Things: Steps toward an Ecology of Matter.” *Political Theory* 32, no. 3 (2004): 347–72.
- Boddy, Kimberley, Sean Carroll, and Jason Pollack. “Why Boltzmann Brains Don’t Fluctuate into Existence from the De Sitter Vacuum.” *Proceedings of the Philosophy of Cosmology Conference in Tenerife, CALT-TH-2015-025* (2015).
- Blok, Anders, and Morten Pedersen. “Complementary Social Science? Quali-Quant Experiments in a Big Data World.” *Big Data and Society* (2014): 1–6.
- Daston, Lorraine. “Objectivity and Escape from Perspective.” *Social Studies of Science* 22, no. 4 (1992): 597–618.
- Daston, Lorraine, and Peter Galison. “The Image of Objectivity.” *Representations*, no. 40 (1992): 81–128.
- Dyson, Lisa, Matthew Kleban, and Leonard Susskind. “Disturbing Implications of a Cosmological Constant.” *Journal of High Energy Physics* 0210, no. 011 (2002).
- Farman, Abou. “Re-enchantment Cosmologies: Mastery and Obsolescence in an Intelligent Universe.” *Anthropological Quarterly* 85, no. 4 (2012): 1069–88.
- Gell, Alfred. *Art and Agency: An Anthropological Theory*. Oxford: Oxford University Press, 1998.
- Haraway, Donna. *Modest_Witness@Second_Millennium.FemaleMan®_Meets_Oncomouse™*. New York: Routledge, 1997.
- . *Simians, Cyborgs, and Women: The Reinvention of Nature*. London: Free Association Books, 1991.
- . “Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective.” *Feminist Studies* 14, no. 3 (1988): 575–99.
- . *When Species Meet*. Minneapolis: University of Minnesota Press, 2008.
- Helmreich, Stefan. *Sounding the Limits of Life: Essays in the Anthropology of Biology and Beyond*. Princeton, NJ: Princeton University Press, 2015.
- Henare, Amiria, Martin Holbraad, and Sari Wastell. “Introduction: Thinking through Things.” In *Thinking through Things: Theorising Artefacts Ethnographically*, edited by Amiria Henare, Maetin Holbraad, and Sari Wastell, 1–31. Oxon: Routledge, 2007.
- Ingold, Tim. *Being Alive: Essays on Movement, Knowledge, and Description*. Abingdon: Routledge, 2011.
- . “Prospect.” In *Biosocial Becomings: Integrating Social and Biological Anthropology*, edited by Tim Ingold and Gisli Palsson, 1–21. Cambridge: Cambridge University Press, 2013.
- Kirksey, S. Eben, and Stefan Helmreich. “The Emergence of Multispecies Ethnography.” *Cultural Anthropology* 25, no. 4 (2010): 545–76.
- Kohn, Eduardo. *How Forests Think: Toward an Anthropology beyond the Human*. Berkeley: University of California Press, 2013.
- Latour, Bruno. *Reassembling the Social: An Introduction to Actor-Network Theory*. Oxford: Oxford University Press, 2005.

- . *We Have Never Been Modern*. Translated by Catherine Porter. Cambridge, MA: Harvard University Press, 1993.
- Law, John. "Making a Mess with Method." Centre for Science Studies, Lancaster University, Lancaster, 2003. www.comp.lancs.ac.uk/sociology/papers/Law-Making-a-Mess-with-Method.pdf.
- Leach, James. "The Self of the Scientist, Material for the Artist: Emergent Distinctions in an Interdisciplinary Collaboration." *Social Analysis* 55, no. 3 (2011): 143–63.
- Lee, Nick, and Steve Brown. "Otherness and the Actor Network: The Undiscovered Continent." *American Behavioral Scientist* 37, no. 6 (1994): 772–90.
- Mauss, Marcel. *The Gift: The Form and Reason for Exchange in Archaic Societies*. New York: Routledge, 2002.
- Myers, Natasha. *Rendering Life Molecular: Models, Modelers, and Excitable Matter*. Durham, NC: Duke University Press, 2015.
- Myers, Natasha, and Joe Dumit. "Haptic Creativity and the Mid-embodiments of Experimental Life." In *Companion to the Anthropology of the Body and Embodiment*, edited by Frances L. Mascia-Lees. Oxford: Wiley-Blackwell, 2011 (239–261).
- Nagel, Thomas. *The View from Nowhere*. Oxford: Oxford University Press, 1992.
- Page, Don. "Is Our Universe Decaying at an Astronomical Rate?" *Physics Letters B*, no. 669 (2006): 197–200.
- . "Is Our Universe Likely to Decay within 20 Billion Years?" *Physical Review D* 78, no. 6 (2008).
- Rees, Martin. *Before the Beginning: Our Universe and Others*. New York: Simon and Schuster, 1997.
- Rheinberger, Hans-Jörg. *An Epistemology of the Concrete: Twentieth-Century Histories of Life*. Durham, NC: Duke University Press, 2010.
- Smolin, Lee. *The Trouble with Physics: The Rise of String Theory, the Fall of a Science, and What Comes Next*. Boston: Houghton Mifflin Harcourt, 2006.
- Stengers, Isabelle. *The Invention of Modern Science*. Minneapolis: University of Minnesota Press, 2000.
- Tsing, Anna L. "More-Than-Human Sociality: A Call for Critical Description." In *Anthropology and Nature*, edited by Kirsten Hastrup, 27–42. New York: Routledge, 2013.
- Valentine, David, Valerie A. Olsen and Debbora Battaglia. "Extreme: Limits and Horizons in the Once and Future Cosmos." *Anthropological Quarterly* 85, no. 4 (2012): 1007–26.
- Vilenkin, Alexander. "Freak Observers and the Measure of the Multiverse." *Journal of High-Energy Physics*, 0701.092 (2007).
- Viveiros de Castro, Eduardo. "Exchanging Perspectives: The Transformation of Objects into Subjects in Amerindian Ontologies." *Common Knowledge* 10, no. 3 (2004): 463–84.