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Who owns NATURE? Conceptual appropriation in discourses on climate and biotechnologies

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Abstract
Emerging technologies can have profound conceptual implications. Their emergence frequently calls for the articulation of new concepts, or for modifications and novel applications of concepts that are already entrenched in communication and thought. In this paper, we introduce the notion of "conceptual appropriation" to capture the dynamics between concepts and emerging technologies. By conceptual appropriation, we mean the novel application of a value-laden concept to lay a contestable claim on an underdetermined phenomenon. We illustrate the dynamics of conceptual appropriation by analyzing the concept NATURE and its uptake in three discourses of emerging technology: cellular agriculture, solar geo-engineering, and biomimicry. We argue that NATURE and its cognate NATURALNESS are strongly valanced concepts upon which different stakeholders lay a claim. In doing so, stakeholders advance distinct conceptions of nature, typically to suit their own interests. Our case-studies illustrate how in discourses on emerging technology, the application of value-concepts is entangled with ideological stakes and power dynamics.

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Introduction

Concepts lie at the core of our thinking and understanding of the world. The conceptual schemes that humans employ—that is, the conceptual repertoires that give shape to human communication and thought—do not have a static or fixed content: they change over time, under the influence of experience, education, communication, science, culture, and technology (Carey, 1985; Gopnik, 1988; Thagard, 1990; Vosniadou et al., 2013). Some conceptual changes involve the introduction of entirely novel concepts. An example is the concept GENE, which emerged during the second half of the 19th and the early 20th century (Falk, 2009) and revolutionized the way we think about inheritance and evolution.[1] However, conceptual changes may also involve subtle amendments and revisions of concepts that have long been entrenched in human language and thought. Consider the concept INTELLIGENCE, which was typically reserved for human beings, but has additionally become associated, from the 1950s onwards, with animals and artifacts. Arguably the concept's evolution can be witnessed in action, as recent discussions of "hybrid intelligence" and "distributed intelligence" suggest.[2]

In this article, we focus on a specific conceptual dynamic that pertains to the concepts NATURE and its cognate NATURALNESS.[3] The concept of nature lies at the heart of many important topics of current societal debate, such as the climate and biodiversity crises, as well as questions of sustainability and human development. Yet the concept is ambiguous and has given rise to convoluted and often opposing connotations (Daston, 2019; Ducarme and Couvet, 2020; Fink, 2006; Glacken, 1967; Latour, 2017; Neyrat, 2018; Vogel, 2015). Conceptualizations of nature range from nature understood as a passive object to be studied and controlled, to nature as something that is free from human intervention and inherently good. The latter conceptualization is reflected, for instance, in the allusions to nature and naturalness that marketeers habitually apply to various goods, such as wine or skin-care products (Levinovitz, 2021).

Emerging technologies play an ambivalent role in the discourse on nature and naturalness, and their shifting connotations.[4] On the one hand, the concept of nature is often posed against the artificial and the technical. But simultaneously, with the societal call for sustainable and responsible technology development, the technology sector is increasingly working on technologies for which "the artificial," "the technical," and "the natural" are not posited as exclusive opposites. Three emerging technologies that exemplify this trend are solar climate engineering, cellular agriculture, and biomimicry. As stakeholders who engage with these emerging technologies seek to employ the concepts NATURE and NATURALNESS in some way or the other, the question arises how this affects these concepts in turn.

Our aim in this paper is to analyze how the concepts of nature and naturalness are shaped in the interplay with New and Emerging Science and Technology (NEST) and to develop conceptual tools that facilitate this analysis. A key notion we advance to this effect is

conceptual appropriation. The section "Conceptual appropriation" starts with the observation that the concepts of nature and naturalness are frequently regarded as value-concepts, which stakeholders seek to "appropriate," as we call it. This means that stakeholders exploit the fact that these are thick concepts with vague and complex application conditions, on which they lay a contestable claim, often to benefit from the positive valence of the concept. The section "Conceptual appropriation in NEST: Three case-studies" proceeds with three case-studies that exemplify how NATURE and NATURALNESS are appropriated in discourses of emerging technology. "Discussion and conclusion" section concludes by highlighting general findings that emerge from these case-studies about the concept of nature and the phenomenon of conceptual appropriation.

Conceptual appropriation

Nature has been characterized as one of the most complex terms in the English language (Williams, 1976). It expresses an essentially contested concept (Gallie, 1955), that is, its contents are essentially a matter of controversy between people with different views, interests, and values. Like many important philosophical concepts, the concept of nature is *overdetermined* (defined in various ways) and *underdetermined* (no single definition seems adequate). In colloquial language, we may loosely talk of *the* concept of nature, like we loosely talk of *the* concept of love or *the* concept of war. On closer inspection, however, people have different concepts of nature (and love and war), which are associated with the same word or label—a property known as *polysemy* (Löhr, 2021; Recanati, 2017; Vicente, 2018).

For instance, people can apply the concept of nature to things that are not human or produced by humans—say, a naturally developed forest or riverbed. But they can also use it to *include* humans, since humans and their products are part of nature in the sense that there is nothing unnatural or supernatural about them. It is clear, then, that the term "nature" has different senses. De Graeff et al. (2022) identify four such senses: (a) nature as biophysical reality; (b) nature as the non-human; (c) entangled nature; (d) nature as the essential characteristics of a thing. Furthermore, one can discern different conceptions and connotations that pertain to each of these (cf. Andersen et al., 2022).

Like NATURE, the adjective NATURALNESS has different senses and counterparts. With the term naturalness, people may denote the property of being naturalistic, that is, not supernatural or in principle beyond the reach of the natural sciences. Alternatively, they may denote the property of being derived from nature without human impact. They may also denote, however, the property of consisting of naturally existing components—as opposed to synthetical human-made components. To make things even more complex, things can be natural to different degrees (a property of many concepts called "vagueness"). One object may be classified as natural because it consists of over 50% of ingredients that are not human-made or synthetically produced. Critics might reject this classification, however, and claim that only something that is "100 percent natural" may be classified as such.

The abundance of understandings, connotations and potential applications of NATURE and NATURALNESS can be explained in terms of so-called "rich meaning" accounts of word meanings and concepts (e.g. Vicente, 2018; Löhr and

Michel, 2022). Concepts are linked to very complex and rich bodies of information, comprising a plethora of prototypes, exemplars, and theory-like beliefs about—in this case—what "nature" is or what it means to be "natural." These "features" as psychologists call them (Machery, 2009) often have a family resemblance structure (Wittgenstein, 2010), which means that none of them is necessary, and each tends to be vague. As long as some features are met to some degree, it can be said that an application of a concept is permissible.

The ambiguity and flexibility of these rich informational structures allows different speakers to apply the same concepts in very different, and possibly opposing narratives. For example, a product may be deemed "unnatural" because it consists of synthetic components, but the very same product might be called "natural" because of the minor role that humans play in its production. Importantly, producers and marketeers often have an incentive to emphasize such different aspects and to claim the concept of nature for their own narratives, since nature and naturalness typically have decidedly positive connotations (they are so-called "thick concepts," that is, they have a pronounced value component).

Emerging technologies provide fertile ground for struggles over conceptual claims. NEST engenders novelties of all sorts: new entities, new spaces of interaction, new human practices, etc. (Brey, 2018; Verbeek, 2011). What is important, in the present context, is that NEST also involve conceptual novelty in describing the technologies, and the products they generate. During the stage of its emergence, when the specific shape, function, and societal implications of a new technology are not yet fully crystalized, the cluster of concepts that people use to refer to a technology and its products, and the value-terms they use to describe them, is similarly malleable. There are different prototypes and exemplars that might be applied to the emerging technology, yet which descriptors are most appropriate is still up for debate; different candidate concepts can plausibly fit the bill (Hopster and Löhr, 2023 describe this as a "conceptual overlap").

At the same time, there is a need to conceptualize the new technology in specific terms, which may call for a specification of existing concepts. The concepts NATURE and NATURAL are informationally rich and therefore potentially applicable to many cases of technological novelty: they provide some degree of conceptual guidance—often with clear evaluative connotations—which is conducive to interpreting the emerging technology in a specific vein, and to conveying which norms and values are associated with it.

This brings us to the notion of *conceptual appropriation*, which we understand as follows:

> **Conceptual appropriation** is the novel application of a complex, ambiguous, or vague concept to a phenomenon that is disputed or underdetermined, thereby laying a contestable claim on the phenomenon.

We will illustrate this account of conceptual appropriation using the concept NATURE as our example. People often use NATURE as a thick concept: that is, a concept that does not only have a descriptive but also a normative component (Kirchin, 2013; Vaerynen, 2013).[5] In contemporary Western societies, there is significant consensus about nature's positive value (Levinovitz, 2021). Nature and naturalness are frequently (though not in every context) regarded as good, something to be promoted,

or at least not to be opposed. Nature is embraced as a value, increasingly so in the face of environmental harm and climate dangers. This endorsement is culturally and historically specific (e.g. Daston, 2019), but firmly anchored in many contemporary worldviews and reflected in conceptual schemes. For instance, in public discourse, "natural" is often used as a synonym for "healthy," "clean," and "responsible." Conversely, references to what is unnatural latch onto values, beliefs, hopes, and anxieties that are negatively valenced (Nuffield Council on Bioethics, 2015).

The positive moral and ideological charge of thick concepts like NATURE is a key feature that drives the dynamics of conceptual appropriation. Stakeholders involved in emerging technology discourses seek to appropriate this thick concept for their own, often prudential, purposes. Their application of the concept is often *non-paradigmatic*: this means that only some central aspects of its meaning apply, but not others. This non-paradigmatic application maybe nontransparent and can be used deceptively—for instance, by marketeers who want to sell their products and convince consumers of their use. Other stakeholders may criticize such uses as instances of *misappropriation*. Hence, one may think of conceptual appropriation as a struggle about the application of thick concepts in the face of descriptive indeterminacy, which is triggered, in turn, by technological novelty.

The term "conceptual appropriation" thus highlights that concepts are often not strictly delineated and can therefore feature in arguments defending quite contrary claims. This is especially the case for a concept as rich, widespread, and colloquial as NATURE—a powerful signifier, yet highly malleable in what is signified. The extension of this concept is subject to power struggles: stakeholders seek to make the concept their own, to match their own worldviews and potentially not that of others. They exert power over meaning.

However, calling something an instance of conceptual appropriation is not necessarily intended to indicate a negative moral judgment.[6] Instead, we reserve the abovementioned term conceptual misappropriation for the subset of conceptual appropriations that are explicitly dismissed on moral grounds.[7] The point of calling something a case of conceptual appropriation is to signal that the novel way in which people use a concept is *contentious*, as the norms for conceptual application are still unsettled. It signals that the speaker relies on the vagueness and richness of the meaning of the term to apply it to a non-paradigmatic object or event, which is a contestable conceptual application.

To illustrate, suppose that a food producer introduced a new product: a beef burger made from stem cells of cows, developed without slaughtering any cows. The producer may reasonably sell this burger as "natural" if it meets some features of the meaning of NATURAL; not all features are required to be present for the concept to apply (see Figure 1). If the burger is made of organic materials or added chemicals, the producer can claim that it is "natural" or "more natural" than the beef burgers of its competitors, which contain added chemicals like antibiotics. These competitors, in turn, may declare the product "unnatural" since it was created by humans in a lab. Both parties are appropriating the concept to further their interest, and it is a matter of debate whether either classification is correct or incorrect (making this an essentially contested concept).

Note that there are often real stakes involved in appropriating concepts. Consider cases of NEST, where the conceptualization of the technology itself, and the value-concepts

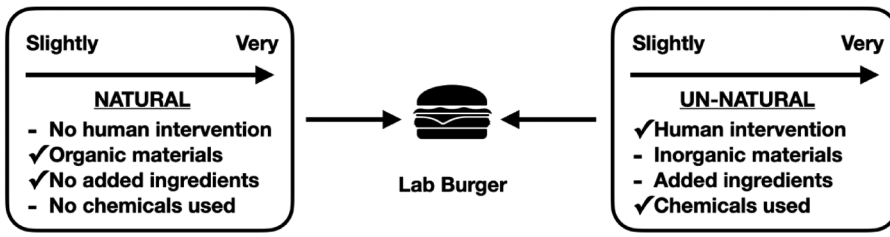

Figure 1. An illustration of conceptual appropriation.

with which it gets associated, can have a major influence on the public perception of a technology and its products. Accordingly, efforts at conceptual appropriation engender moral risks: in the hands of clever marketeers, novel applications of the concept of nature lend themselves to greenwashing. The potential for conceptual misappropriation, then, is one of the reasons why this phenomenon should be of ethical concern. But apart from its ethical relevance, we submit that the phenomenon is also of general philosophical interest, as it sheds light on mechanisms of conceptual disruption (Hopster and Löhr, 2023; Löhr 2023) and on the mediating role of concepts in processes of technomoral change (e.g. Hofbauer, 2022).

The concept of nature is a clear target for conceptual appropriations in discourses of NEST, but not the only concept that is frequently appropriated.[8] We conjecture that various other concepts are likely to fall prey to similar power struggles, especially if they satisfy the following criteria:[9]

1. The concept is vague and ambiguous, and/or its meanings are informationally complex (constituting a kind of family resemblance structure whereby none of the features are necessary and sufficient). For instance, there are different concepts and conceptions associated with the single word nature. Polysemy engenders conceptual flexibility: polysemy and vagueness allow a speaker to interpret words in multiple ways and be adopted in different contexts, making them plausible candidates for conceptual appropriation. Many words are semantically underdetermined in the sense that their informationally rich meaning is compatible with different applications that may contradict each other. The stakeholders involved in a discourse can exploit the vagueness and uncertainty of the concept.
2. The phenomenon (e.g. the technological artifact, event, or process) the concept is applied to is conceptually underdetermined. This means that there are different ways of conceptualizing the phenomenon, and it is not obvious how extant concepts should be applied to it, for instance, because the phenomenon is novel. As a result, applying a given concept to the phenomenon is a contestable act.
3. The concept is thick. That is, the concept has both a descriptive and an evaluative component. Its evaluative component is what makes the concept a plausible candidate for appropriation: to apply the concept to a novel phenomenon is to make a value-laden claim to it.

4. The concept is strongly valenced. That is to say, not only does the concept have an evaluative component, but it is evaluated in either a strongly positive or a strongly negative way. This implies that there is much at stake in taking ownership of the concept. If a concept is a positively valenced descriptor, then there is a clear incentive to associate the concept with whatever a stakeholder deems desirable. If a concept is a negatively valenced descriptor, then there is a clear incentive to dissociate the concept from whatever a stakeholder deems as desirable.

Concerning the concept of nature, each of these criteria is in place, raising the likelihood that the concept will fall prey to struggles for conceptual appropriation. In the next section, we will illustrate how these struggles shape three discourses of NEST: cellular agriculture, solar climate engineering, and biomimicry.

Conceptual appropriation in NEST: Three case-studies

In this section, we scrutinize how NATURE is appealed to in three domain-specific discourses of emerging technology. We will argue that in each of these discourses, the normative connotations of NATURE are salient, instigating conceptual appropriations by different stakeholders. However, they are not conceptual appropriations of the same kind: in each case, the concept of nature is appropriated with appeal to different conceptual features, giving rise to various domain-specific conceptualizations of NATURE.

Cellular agriculture

Cellular agriculture is a set of biotechnologies that allows for the production of agricultural commodities using cell cultures or host micro-organisms, instead of farmed animals or crops. Through cellular agriculture, lab-grown food ingredients can be produced, such as protein (meat, fish, milk, cheese, eggs), lauric acid (to replace palm oil), carbohydrates (to replace flour), but also non-food substances such as drugs (insulin), animal-derived products (leather, silk), and chemicals (biofuel). The technology has the potential to disrupt traditional ways of food production, for instance by replacing cows as a protein source with engineered cells cultured in bioreactors, or by replacing flavors that are chemically synthesized with flavors that are produced by engineered microbes.

The concepts of nature and naturalness play an important role in the discourse surrounding this emerging technology. They do so in complex and sometimes ambiguous ways, which is typical for discussions about naturalness in food labeling more generally (Sandin, 2017).

Proponents of cellular agriculture frame the technology to echo the positive connotations of NATURALNESS, emphasizing that cellular agriculture offers a way to produce food with the help of natural processes. For instance, *Proveg International*, a non-governmental organization dedicated to reducing global animal consumption, writes that cellular agriculture products are "just as natural" as traditional foods such as cheese (Proveg International, 2020), using the concept NATURALNESS to point to the (chemical) equivalence of cellular agriculture products to conventional products. Similarly, cellular agriculture companies are promoting their products as "natural" or

as produced through "natural processes" (Guthman and Biltekoff, 2020). They claim to work "with nature" to create sustainable products, as a company in sustainable leather does (Vitrolabs, 2020). Proponents claim cellular agriculture "takes nature's most elemental building blocks," such as cells, to produce animal-free food (Cellular Agriculture Society, 2021). As de Graeff et al., 2022 (p. 19) observe, using labels like "natural" can be interpreted as a rhetorical strategy to "naturalize" biotechnology, thereby yielding positive connotations.

Yet, not all stakeholders involved in the discourse on cellular agriculture support the appropriation of NATURALNESS by biotechnology. Critics debunk claims about the naturalness of these early-stage technologies. For instance, in 2018, the United States Cattlemen's Association argued that the label "meat" should be reserved for products that are "derived naturally from animals as opposed to alternative proteins such as plants and insects or artificially grown in a laboratory" (United States Cattlemen's Association, 2018). Following this line of reasoning, products derived from crops instead of the lab should be considered natural. Others who have questioned the use of the label "natural" in cellular agriculture, attempt to warn against the unforeseen consequences of the technology, such as its ecological impacts. For instance, the ETC Group ("Erosion, Technology and Concentration"), an action group that addresses socio-economic and ecological issues surrounding new technologies, states the following in response to labeling genetically modified fibers as "natural" by the company producing them:

> (..) the payoff of synbio fiber production is cheaper high-value fibers produced in factory-based fermentation tanks that require fewer workers – all under the green guise of "natural" sustainability. A closer look reveals that there is nothing natural or sustainable about synthetic biology's high-tech (..) approach to novel fiber production (ETC Group, 2018: 2).

According to the ETC Group, in appropriating the concept NATURALNESS, these tech firms are trying to hide the highly technological setting in which these so-called "natural" fibers are produced. On these critics' reading, using micro-organisms for cellular agriculture alone does not make cell agriculture products natural. The wider ecological setting matters too. The designation of being "natural" cannot be earned based on only one element or one part of a production process, which is embedded in a highly artificial setting. Instead, the concept of naturalness should be reserved to designate the overall integrity of ecosystems, the whole of ecological relations. This is a good illustration of a conceptual struggle: tech firms appropriate the concept NATURALNESS drawing on some of its conceptual features, while a civil society stakeholder accuses them of abusing it, drawing on other conceptual features. Indeed, the civil society stakeholder frames cellular agriculture as "unnatural" or "artificial," thereby invoking negative connotations.

One interesting finding of the use of naturalness in the debate on cellular agriculture is the striking flexibility in the way the technology is deemed natural or unnatural. As food grown in a laboratory can be perceived as unnatural, food producers are inclined to make statements about the naturalness of food products (Helliwell and Burton, 2021). Taking the example of cell-based meat, a public opinion poll indeed

suggests that meat from livestock farming is considered more natural than cell-based meat (Moritz et al., 2022), due to the latter's sterile environment of bioreactors and the genetic modification of cells. In seeking to disavow the label UNNATURAL, proponents of cellular agriculture, stress the "unnatural" elements like antibiotics that are involved in livestock farming and emphasize that those are not part of cellular agricultural protein production (Proveg International, 2020).

To conclude our first case-study, then, while there is a plethora of different interpretations of naturalness in cellular agriculture, we can distinguish at least two appeals that frame NATURE/NATURALNESS in specific, incompatible ways. On the first, reductionist framing, adopted by proponents of cellular agriculture, a claim to naturalness alludes to the constituents of the production process. The concept of nature is used in a decontextualized way, referring to a specific constituent—microbes—that are used in a highly technological setting. In the second, holistic framing, NATURE/NATURALNESS is understood in an integral, holistic way. Using micro-organisms for cellular agriculture alone does not make cell agriculture products natural, as the methods of production cannot be meaningfully separated from the wider environment. The ecological setting matters for the application of the concept of NATURE/NATURALNESS.

These different applications of the concept of nature, in turn, give rise to two diverging conceptual appropriations (Table 1). Proponents of cellular agriculture make a contestable claim to the "naturalness" of cellular agriculture, by singling out the role of microbes in the technology. Opponents make a contestable claim to the effect that cellular agriculture is unnatural, by emphasizing that assessments of naturalness should be made on a holistic basis.

Table 1. Two ways in which the concept of naturalness is applied in the discourse on cellular agriculture, yielding conflicting appropriations of what is "natural" and "unnatural."

Stakeholder	Proponents of cellular agriculture	Opponents of cellular agriculture
Application of nature/ naturalness	The concept of naturalness is applied in a reductionist, decontextualized way	The concept of naturalness is applied in a holistic, integral way
Conceptual appropriation	Cellular agriculture is natural	Cellular agriculture is unnatural

Solar geo-engineering

Stratospheric Aerosol Injection is a technology proposed to reduce some of the more drastic climate harms, by altering the Earth's atmosphere.[10] The approach involves spraying aerosols into the stratosphere, which would scatter a small amount of the incoming sunlight and consequently slightly cool the Earth's surface temperature. Its promise notwithstanding, the technology carries significant risks and uncertainties and has been challenged from societal and climatological perspectives (for overviews, see Preston, 2016; Pamplany et al., 2020).

The debate surrounding SAI, as it relates to the concept of nature, can best be understood with reference to the framing of the technology. The first account, advanced by proponents of SAI, frames nature as something that human beings have always interacted with. It is difficult to regard nature as a genuinely separate realm, for what might appear to be the realm of the non-human, has been affected by human influences through and through. Furthermore, altering, controlling, or mastering what may appear to be the "natural" realm is not inherently wrong. Nature holds no intrinsic moral value and provides no inherent moral guidance.

Indeed, assuming that prima facie there is nothing inherently wrong with intervening in the natural world, SAI can be seen as "a cheap tool that could green the world" (Keith, 2013: x), thus actually protecting the natural realm. This is justified by the claim that the Earth needs to be managed and "stewarded" (Steffen et al., 2011), as the dawn of the Anthropocene has finally eliminated any barrier between humanity and nature (if such a barrier ever existed). "It's no longer us against 'Nature'. It's we who decide what nature is and what it will be" (Crutzen and Schwaegerl, 2011: n.p.).

For better or for worse, humans inevitably shape the planet, and thus the distinction between the "natural" and the "human-made" or "influenced" becomes increasingly blurry and untenable. Since "[n]ature no longer runs the earth," but rather, humanity does (Lynas, 2011: 8), intervening in nature becomes inevitable, necessary, and the responsible thing to do. While some scholars from this field agree that SAI is a risky intervention, the "climate emergency" justifies its potential deployment as a "bad idea whose time has come" (Kintisch, 2010).

This conceptualization of nature opposes a supposed "deep green environmentalism." David Keith, one of the most prominent pro-research voices, argues that "environmentalists should abandon the obsessive defense of pristine nature in favor of an expanded environmental ethic that embraces the messy but vibrant reality of landscapes shaped by human action." (Keith, 2013: xviii). Accordingly, the natural world is something that human beings can, and perhaps even should, intervene in. The stakeholders—in this case mostly researchers in favor of SAI research—appropriate nature in a way that denies, or at least questions, the supposedly pristine and untouchable moral status of the natural world.

By contrast, critics of SAI warn against human hubris, arrogance, and emphasize the risks of large-scale climate interventions (Hamilton, 2014; Pierrehumbert, 2015; Robock et al., 2009). Some skeptics of SAI seek to "de-center humans from the moral universe" (Batavia and Nelson, 2017: 374), highlighting the intrinsic moral value of the natural beyond the human realm. In their view, solar climate engineering represents a hubristic intervention in a climate system we barely understand and is the technological manifestation of (parts of) humanity's blatant disregard for nature.

Opponents of SAI also appropriate the term nature, by highlighting the "unnaturalness" of the technology. This appropriation has a precautionary and a rhetorical upshot. In precautionary terms, framing SAI as a breach of nature serves to foreground the epistemic limitations of actions that go beyond human understanding, and to discard these as forms of hubris. SAI reduces the complexity of the earth system to the variable of solar radiation (Hamilton, 2017) and is "[…] wildly, utterly, howlingly barking mad" (Pierrehumbert, 2015: n.p.). The many risks and uncertainty the technology brings "fl[y] in the face of precaution" (ETC, 2018: 3). This stands in stark contrast with

the abovementioned understanding of nature as something that can be observed, controlled, and even mastered.

While the stigma of unnaturalness has been repeatedly questioned (Levinovitz, 2021; Marris, 2011; Vogel, 2015), it remains a powerful concept in terms of public communication. This brings us to the second upshot of appropriating NATURE to oppose SAI: its rhetorical force. SAI's supposed unnaturalness is what Jeremy Baskin identifies as one of the main obstacles for SAI not being popular in policy circles (so far) when he writes about "the strength, persistence and public resonance of the idea that [SAI] is un-natural and therefore unwise. The claim of [SAI's] necessity struggles to break through this centuries-old, ontological barrier between the social and the natural."[11] (Baskin, 2019: 154)

To sum up, in both cases, the concept of nature is conceptualized in distinct ways to provide normative guidance with respect to the ethical acceptability of SAI (Table 2). SAI-proponents typically argue that there is no clear divide—let alone a morally significant distinction—between what is natural and unnatural, whereas opponents emphasize the riskiness of SAI, precisely by virtue of its unnaturalness. It bears pointing out that experimental findings suggest that the latter conceptualization resonates with the public: whether climate interventions are perceived as "natural" or "unnatural" is an important predictor of whether they are regarded as socially acceptable (Bellamy and Osaka, 2020). For instance, it turns out that laypeople's acceptance of SAI increases when it is presented as a "natural" solution, for instance by pressing the analogy that "SAI mimics a volcano," as opposed to claiming that SAI entails "chemicals in the stratosphere," or that it relies on "a large industrial complex" (Corner et al., 2013; Corner and Pidgeon, 2015). The connection between "naturalness" and social acceptance constitutes an important incentive in struggles for conceptual appropriation.

Table 2. Two ways in which the concept of nature is applied in the discourse on stratospheric aerosol injection.

Stakeholder	Proponents of SAI research	Opponents of SAI research
Application of nature/ naturalness	Detach the concept of nature from pristineness and intrinsic value. Insofar as there is a natural world, humans are part of it	Ascribe intrinsic value to nature. Human and natural realms are clearly distinct, and large-scale human intervention in nature is hubristic and risky
Conceptual appropriation	SAI is not distinctly unnatural (and if it is, then so is everything else)	SAI is unnatural

By questioning a firm distinction between what is "natural" and "unnatural," SAI-proponents make a contestable claim that the technology is not distinctly unnatural (as "nature" is already human through and through). By contrast, SAI opponents make a contestable claim about the "unnaturalness" of the technology.

Biomimicry

Biomimicry is growing in popularity due to the increasing demand for sustainable technologies (Gerbaud et al., 2022; Lenau and Lakhtakia, 2021; Palombini and Muthu, 2022).

Also known as biomimetics or bio-inspired design, biomimicry (from the Greek *bios*, life, and *mimesis*, imitation) consists in the conscious emulation of biological models in technical design, with the aim of solving today's technical and ecological challenges (Benyus, 1997). The selective pressures of natural evolution have led to very efficient design solutions, which designers can borrow from to solve human problems. For example, the water-repellent properties of lotus leaves inspired effective self-cleaning paint.

However, the "biomimetic promise" (Gleich et al., 2010) for sustainable innovation is complicated by a series of ambiguities that pervade how nature is conceptualized in biomimetic design (Gerola et al., 2023). Biomimetic designers acknowledge that design solutions found in nature are "not always optimal, ideal, elegant or perfect" (Cohen and Reich, 2016: 15). Deriving a design idea from nature requires a creative process of interpretation and translation from biology to technology, where a specific biological strategy is abstracted and translated into technical design (Vincent et al., 2006). Describing an innovation as "biomimetic" or "inspired by nature" is therefore not a neutral operation and may lead to contestable claims, especially if such descriptions are sought in the interest of marketing gain by leveraging on the positive valence of NATURE. As Fadok (2022: iii) observes, "while biomimics aspire toward artifacts that truthfully resemble nature, (…) in practice, the meaning of resemblance is multiple and situated." The "nature" in "nature-based design," he argues, is a rather open term, which entrepreneurs and consultants can use to manipulate and pursue profit. What counts as biomimetic depends on what counts as natural, or nature-based. Different approaches to biomimetic design formulate different answers to this, thereby appropriating conceptions of NATURE and NATURALNESS to support their own approach.

One could make a division between two camps in the biomimicry community (Table 3). The first camp takes nature to be a repository of ideas that can be used for inspiration. The second takes biomimicry (again, generally understood as "inspired by nature") to entail a normative obligation to follow or be in line with nature. Let us consider these "innovation-focused" and "sustainability-focused" camps in turn.

The first camp is usually referred to as biomimetics and it focuses on transferring insights from biological sciences to engineering (Hashemi Farzaneh and Lindemann, 2019; Lepora et al., 2013). A biomimetic technology in their view has been "developed on the basis of the transfer of knowledge (operating principles, manufacturing processes) gained from one or several biological concept generators" (Speck et al., 2017: 7). This definition excludes the direct use of biological material, such as in biotechnology, and ensures that the imitation is functional and not merely esthetic. Since the focus of biomimetics is on the transfer of nature's design ideas, nature itself is described as "an enormous pool of inventions that passed the harsh test of practicality and durability in changing environment" (Bar-Cohen, 2006), a generator of ideas that offers a designer "four billion years' worth of 'R&D'" (Vincent and Mann, 2002). By describing nature as a repository of clever technical designs, designers not only highlight its epistemic value as an "innovation engine" (Cohen & Reich: 7), but it also allows them to capitalize on the implicit public perception of the sustainability of biomimetic design, potentially contributing to the greenwashing of the technology. Sustainability, in fact, is often not the main concern in biomimetics (Landrum and Mead, 2022).

The second (sustainability-focused) camp in the community follows Janine Benyus' "Biomimicry Approach," according to which "ecological sustainability" is and should be the core focus of biomimicry. The notion of ecological sustainability essentially consists in "learning from and then emulating natural forms, processes, and ecosystems to create more sustainable designs" (Baumeister et al., 2014: 81). A good biomimetic innovation must not only integrate knowledge derived from biology but also be regenerative, imitating nature's capacity to conduce to new life (Baumeister et al., 2014: 29). "Regeneration," on this account, is achieved by following "Life's Principles," which represent nature's strategies for survival. Life's Principles include nature's properties of self-organization and adaptability, but they also require using "life-friendly chemistry," which is water-based and breaks down products into benign constituents, employing "readily available materials and energy," cultivating "cooperative relationships," and by being resource efficient, recycling all materials employed (Cohen and Reich, 2016: 14). In other words, for the Biomimicry Approach, nature is not only a repository of ideas, but also a model, measure, and mentor of sustainable innovation. "After 3.8 million years of evolution, nature has learned: What works. What is appropriate. What lasts." (Benyus, 1997: xi).

The first camp in the biomimicry community applies the concepts NATURE and NATURALNESS in a way that emphasizes their functional features, biological processes, materials, structures, and principles of evolutionary success while denying that sustainability constitutes an *intrinsic* property of biomimetic technologies (Gleich et al., 2010: 2). However, when it claims that biomimetic innovations are "nature-based" or "nature-inspired," it also benefits from nature's positive valence by appearing implicitly related to sustainability. The second camp or approach to biomimicry, on the other hand, appeals to a stronger sense of NATURE in which it is not only just a repository of ideas, but also a wise mentor that can teach us how we should develop our technologies, namely, to also benefit the larger ecosystem. Biomimetic innovations that simply imitate a functional aspect of nature but do not result in more sustainable solutions, such as the Japanese bullet train that is inspired by the Kingfisher's bill, would be considered poor examples of biomimetic design that are just "stealing ideas from nature" (Vincent, 2001). This goes to show that the conceptualization of NATURE by biomimics is inherently selective: it does not merely offer a representation, but rather a *selective articulation* of what wisdom nature holds in store. Given that such articulation is inherently contestable, and keeping in mind that the "biomimetic" label can have serious marketing gains, this can be seen as an act of conceptual appropriation.

Table 3. Two ways in which the concept of nature is applied by biomimetic designers.

Stakeholder	Biomimetics designers, camp 1	Biomimicry approach, camp 2
Application of nature/naturalness	Nature as a repository of design ideas, is not necessarily sustainable	Nature as model, measure, and mentor of sustainable development
Conceptual appropriation	Biomimetics as "nature-inspired"	Biomimicry approach as "nature-friendly"

Both camps appropriate the concept of nature, yet with different emphases.

Discussion and conclusion

Who owns NATURE? While concepts are not owned by anyone, it often benefits parties to take ownership of them and advance conceptualizations that suit their own purposes. In this article, we have introduced the notion of *conceptual appropriation* and argued for its use in advancing scholarship on the dynamics between technology and concepts. In contexts of NEST, different stakeholders seek to appropriate the concept of nature to foster their own agendas, thereby transforming the connotations of NATURE and NATURALNESS in specific domains of technology. They do so by relying on different features of the informationally rich concept of nature.[12] Yet, while NATURE has been the focus of our analysis, we conjecture that the phenomenon of conceptual appropriation generalizes and constitutes a useful model for future studies of tech-induced conceptual disruption and change (Löhr, 2023). Furthermore, we reckon that conceptual appropriation constitutes a fruitful lens to scrutinize other morally charged debates in environmental ethics.

To provide a clear outline of the phenomenon (and concept) of conceptual appropriation, we have largely parked the normative discussion about its appropriateness. We submit that detailed standards for assessing the appropriateness of conceptual appropriations would comprise a welcome refinement of our model. This is where work in the burgeoning fields of ethics of technology and conceptual ethics can fruitfully intersect.

Studying three discourses of NEST in detail, we have found that NATURE and NATURALNESS are conceptualized in different ways by different stakeholders. Frequently, these different conceptualizations are at the center of moral and political debate. While we have discussed the three technologies disjunctively, there are certain commonalities between the appropriations of different stakeholders, which arguably latch on to opposing overarching stances in the environmental debate. For instance, the conceptualizations by the first stakeholders are conducive to an "ecomodernist" stance, whereas the conceptualizations by the second stakeholders are conducive to a "deep ecology" stance (Table 4).

The case-studies of conceptual appropriation we have looked at are local in scope: they pertain to conceptualizations of nature in circumscribed domains of discourse. Do these local appropriations also affect the overarching concept of nature? This is an open question, which depends on assumptions about the nature of this overarching concept. Some argue that there is no coherent overarching concept (e.g. Vogel, 2015). Thus understood, local appropriations do not affect the global concept, for there is no such concept to begin with. Others submit that NATURE is a polysemous concept that has some well-described overarching meanings (Ducarme and Couvet, 2020, de Graeff et al., 2022). On this understanding, local appropriations can potentially affect some of the overarching senses of nature.

We have argued that the polysemy, multi-interpretability, and capaciousness of concepts like NATURE facilitate struggles for conceptual appropriation. We emphasize, however, that the same holds for their objects of description: conceptual appropriation is facilitated not only by the heterogeneity of concepts, but also by the interpretative flexibility of emerging technologies. "Interpretive flexibility" has been defined as "the capacity of a specific technology to sustain divergent opinions" (Sahay and Robey, 1996: 260), regardless of a maker's intention or prescribed design. As a consequence, the

Table 4. Opposing conceptualizations of nature in three domains of NEST.

Technology	Conceptualization of nature by stakeholder 1	Conceptualization of nature by stakeholder 2
Cellular agriculture	*Reductionist, decontextualized*	*Holistic, non-fragmented*
Solar climate engineering	*Not intrinsically valuable*	*Intrinsically valuable*
Biomimicry	*Repository of design ideas*	*Standard of sustainability*

same technology can shape social realities in different ways (Doherty et al., 2006) and may afford a multiplicity of—perhaps rivaling—conceptual embeddings.

Note that the interpretative flexibility of technologies itself is partly a function of the labels we use to conceptualize technologies. Each of the three technologies we have discussed—cellular agriculture, solar geo-engineering, and biomimicry—can be relabeled in terms of more specific technologies, relying on very different techniques. Given the polysemy and vagueness of the labels and the fact that they may be associated with positive or negative associations, the words used to describe these technologies can also become an object of conceptual appropriation. Indeed, whether or not cellular agriculture, stratospheric aerosol injection, and biomimetics qualify as TECHNOLOGIES may already be subject to dispute and conceptual appropriation.

In this paper, we have not advanced a specific stance on the usefulness, or lack thereof, of the concept of nature in environmental debate. Instead, we have advanced a conceptual model for analyzing how discourse on nature often proceeds. While concepts play a major role in moral debates about technology and the environment, an analysis of these debates rarely proceeds with a distinct focus on struggles about conceptualization. We believe that a greater sensitivity to the way in which concepts such as NATURE are employed and appropriated by different stakeholders is invaluable to understanding these ongoing debates, as well as intervening in them.

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Author contributions

All contributing authors were involved in discussing the paper's structure and deciding on the core case-studies. J.H., G.L., and P.K. spearheaded the theoretical analysis, J.R., B.H., and A.G. analyzed the case-studies (3.1, 3.2, 3.3, resp.). All authors contributed to the writing, editing, and approval of the final version of the manuscript.

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Notes

1. We follow the convention of the literature on concepts by capitalizing a concept when referring specifically to how the concept is named. We do not capitalize concepts when referring to their conceptual contents.
2. Although concepts are distinct from words, semantic changes and novel word pairs such as "hybrid intelligence" can be indicators of conceptual change.
3. We think of NATURALNESS as being conceptually derivative of NATURE: NATURALNESS instantiates properties associated with NATURE in a certain object or phenomenon.
4. Here and in what follows, we assume a constructivist and pragmatist understanding of nature and naturalness. That is, we assume that the concept is a contingent product of socio-political, historical, and socio-technical construction, employed to make sense of our individual and communal life-world.
5. A further question is whether this use is justified. This is a hotly debated issue with a long pedigree (Daston, 2019), as illustrated by discussions about the naturalistic fallacy. To keep our discussion manageable, here we remain non-committal regarding the question of whether NATURE does indeed constitute thick concept. We merely observe that it is commonly employed as such.
6. In this respect, the concept diverges from the term "cultural appropriation," which is typically understood as the *inappropriate* adoption of another's culture or identity. In principle, however, one could conceive of unproblematic cases of cultural appropriation—say, when two communities do not stand in asymmetric power relations, and one borrows cultural norms from the other, which pleases the other. Our point is that while the term "appropriation" does allude to a contentious act, it need not always be negatively evaluated.
7. Cases of conceptual misappropriation also constitute a subset of what Pozzi (2023) calls "hermeneutical appropriation," that is, the appropriation of hermeneutical resources which gives rise to an epistemic injustice.
8. Other concepts that seem to satisfy the criteria under which conceptual appropriation is likely to occur include, for instance, the earlier-mentioned concept INTELLIGENCE, or the concept FREEDOM.
9. We do not regard these as necessary or sufficient conditions for conceptual appropriation, but rather as conditions that, as a matter of empirical conjecture, increase the likelihood that conceptual appropriation will occur.
10. Framing SAI as a "technology" is itself contestable. Alternatively, one could follow Jeremy Baskin in regarding SAI as a "sociotechnical imaginary, struggling to be born" (Baskin, 2019: 156). This highlights the socio-political dimension of SAI and emphasizes the fact

that the technology is not merely a tool, but a manifestation of ideological framings, values, and power struggles.

11. The critical think tank on Erosion, Technology and Concentration (ETC) invokes a similar rhetoric, when they call to seize SAI research in their H.O.M.E.—Hands off Mother Earth —manifesto (ETC 2018). While the term "nature" is not mentioned in their piece, the term "Mother Earth" arguably serves as its placeholder, as an entity that needs to be protected from transgressional human intervention.
12. As highlighted in the "Conceptual appropriation" section, debates about nature/naturalness may also be about the degree to which some property associated these concepts is present; furthermore, given that the concept of nature is associated with a cluster of attributes, there may be cases of disagreement which nonetheless involve agreement over certain basic attributes associated with nature/naturalness. We thank an anonymous reviewer for pointing this out.

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