

The Cognitive Archaeology of Sociocultural Lifeforms

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Abstract

We draw from the recent enactivist literature to articulate an operational definition of Wittgensteinian forms of life as a self-productive collection of constraints over collective behavior. We propose that humans integrate and enact those account through the Active Inference of shared “regimes of attentions”, which are experienced as embedded normativity within direct engagement with a shared sociocultural niche. Given those elements, we discuss how sociocultural lifeforms “encode information” in the material niche, and discuss how this information may be recovered by cognitive archaeologists.

Introduction

Wittgenstein, in his *Philosophical Investigations* (Wittgenstein 1953), famously introduced the notion of a language-game to traduce the open-ended, dynamical nature of linguistic conventions: “[T]he term “language-game” is meant to bring into prominence the fact that the speaking of language is part of an activity, or of a form of life.” (Wittgenstein 1953, para. 23). The notion of a form of life should be understood in the context of a broader pragmatic view of language, where meaning derives from use. To follow the rules of language is to participate in a broader network of social activity and expectations, it is (in anachronic terms) to enact a world defined beyond the boundaries of one’s own brain. However, the notion of a form of life, as well as its implication for the social construction of meaning, were never specified in depth by Wittgenstein. The form of life, in the Wittgensteinian sense, however, has been instrumentalized in recent work on affordances, claiming that the social expectations, norms, and cultural practices that make up our human forms of life provide a general form of ecological information that structures the way agents experience affordances as inherently normative (Bruineberg, Chemero, and Rietveld 2019).

We argue in the present paper that Wittgenstein’s “form of life” should be taken literally. Indeed, the rules of language

are elements of a web of constraints over social activity, which successfully work to (re-)produce itself and therefore exhibits a hallmark of biological organization (Montévil and Mossio 2015). The notion of social constraints may be framed as an implication of the way social norms and expectations come to be embedded in the sociocultural and material niche. Most importantly, we want to emphasize the mechanisms enabling normativity to become embedded in a shared niche can be described by the specific notion of perception-action loops formalized in the Active Inference framework (Clark 2020; Hipólito et al. 2021). More specifically, on the construction of a sociocultural landscape of affordances, in which human agents are always and everywhere situated (Bruineberg and Rietveld 2014), which affords (and entails) the very embedding of norms within an agent’s material and sociocultural niche itself. This notion draws from, and reframes, earlier accounts of the role of human agents in enacting the constraints constituting higher order social organization (Guénin--Carlut 2022a; Guénin—Carlut 2022).

To be clear, this work is not the first to elaborate on the deep resonance between Wittgensteinian considerations on the philosophy of language and normativity and enactive theory. We could for example point to Nehaniv et al. (2013), which relates interaction games to Noë and O’Reagan sensori-motor approach, or the treatment of language by contemporary enactive theorists (Cuffari, Di Paolo, and De Jaegher 2015; Froese and Di Paolo 2011). Other works have additionally grounded a theory of meaning in Shannon Information Theory (Nehaniv 1999). However, the goal of this paper is not to elaborate an enactive or information-theoretic account of social interaction. The implicitly representational aspect of Active Inference (as well as its formal grounding in dynamical systems theory) puts it at odds with the enactive approach (E. Di Paolo, Thompson, and Beer 2021), and the constructive aspect of social organization draw us to reject its grounding in the closed state-space representation of dynamical systems or classical information theory (Guénin--Carlut 2022b).

Our goal is instead to provide an intuitive and accessible account of how reframing social organization of “sociocultural landscapes” (formalized within the Active

Inference framework) can affect the ontology and inference processes in cognitive archaeology. More precisely, we wish to investigate what opportunities this account affords for making inference about the constraint constituting past sociocultural forms of life given the traces we have of their existence - in most cases, parcellar elements of material culture alone. We operationalize this inference as a process of “decoding” social constraints that were “encoded” by past forms of life. We first motivate the notion of embedded normativity, which refers to how specific norms and expectations can be effectively anchored in the material niche and reconstructed by human agents. We then describe the process by which sociocultural lifeforms can exist through constraints exerted over patterns of collective behavior, how those constraints preserve collective existence by “encoding” their constitutive constraints in the material socio-cultural niche experienced by their individual constituents. We finally discuss the process by which cognitive archaeologists can “decode” this information, what are the challenges of this mode of inference and how it relates to the existing program of cognitive archaeology. In addition to its direct statement on cognitive archaeology, we hope this contribution will highlight the importance of studying the intrinsic organization of human societies, as well as the relevance of the specific formalism we leverage to do so.

Constraining Experience: the Phenomenology of Embedded Normativity

The notion of an affordance was introduced by Gibson (1979) in his account of ecological perception, to describe how organisms perceive their niches in active terms - as opportunities for action -, rather than simply in terms of perceptual content. Although there is disagreement about how to best define the term ‘affordance’, the consensus view (and most plausible interpretation of Gibson), is that an affordance is best thought of as a relational property; something that emerges from the meeting of some feature of the organism’s niche, and the embodied skills of the organism. For example, for most humans, chairs afford sitting, while steep rock faces afford climbing only to a brave few with the right skillset. Similarly, soil affords burrowing to a worm, but not to most humans. Affordances are a powerful theoretic tool in that they understand and articulate the organism’s niche as fundamentally action orientated; thus, we are prompted to ask not only what materiality constitutes a niche, but how that material shapes and solicits action. Tautologically, affordances are embedded in the experience or perception of cognitive agents, which means that they are embedded (directly or indirectly) in the organization of the specific form of life enacted by cognitive agency. We can experience this daily through the way our direct metabolic needs shape our perception of related objects. We experience food more intensely when hungry, we may even actively look in our surroundings for food items affording eating. Our cognitive and biological organization produces a more salient experience of objects which affords eating, and a stronger attraction toward those objects, when those are metabolically needed.

The biological embedding of affordances can be systematized by calling onto the enactive approach to cognitive science, a research program which is best defined by the study of embodied interactions with the environment and the biological processes shaping cognition. The research program was first articulated through autopoietic theory, which centers around the biological property of autopoiesis (i.e., self-creation) by which proponents emphasized how biological organization continuously and actively re-produce its own organization (Varela, Maturana, and Uribe 1974; Maturana and Varela 1991). This approach to enactivism was later criticized by lacking a clear grounding for the study of cognitive meaning (E. Di Paolo 2005; 2009), revamping autopoiesis with the deflationary notion of autonomy (i.e. self-law) to describes biological self-production while explicitly anchoring it in the material flows and information dynamics that formalizes this process (Barandiaran and Moreno 2008; Ruiz-Mirazo, Peretó, and Moreno 2004). The notion of autonomy is largely identified as one of the defining features of biological organization, and may therefore be recruited as a formal grounding for the broad expression of a “form of life” or “lifeform”. A central feature of autonomy is that it grounds cognitive activity in an intrinsic biological and modulatory normativity (Barandiaran, Di Paolo, and Rohde 2009; Barandiaran and Moreno 2008). To put it simply, there are those events and processes that are coherent with an agent’s process of self-production, and there are those that are not. In order to subsist, any form of life must by construction be able to modulate its engagement with the larger world so as to bring about the first category of events and processes while avoiding the second.

On a basic level, all of this is to say that from an agent’s perspective, affordances aren’t amenable to a neutral description. Perceiving an affordance will evoke specific feelings and attitudes in the perceiving agent, which are viscerally grounded in a fundamental logic of self-affirmation. The demands (push and pulls) toward or away from specific affordances emerge from the interplay between the self-constitutive metabolic processes entailed by an agent’s autonomy and the constraints of the material world. That is the basis for normativity (Allen and Bickhard 2011). Broadly speaking, normativity refers to the capacity of agents to establish, follow, and enforce rules or standards that guide behavior and action in a given context. But unlike the normativity that comes from laws or contracts, the normativity that comes from affordances is experienced by the agent as a property of its environment. We do not feel that we ought to eat when hungry given the word of some unspoken law, we feel drawn toward food items and the act of eating. To some extent, the normativity is indeed embedded in the environment since it emerges from interaction with objects that afford possible interactions. We will describe this phenomenon as embedded normativity.

A critical aspect of human life, as described e.g. in (Bruineberg, Chemero, and Rietveld 2019), is the role social regulation plays in the construction of affordances, and therefore of embedded normativity. Indeed, humans rely heavily on cultural knowledge and (culturally inherited) social organization for their survival (Boyd, Richerson, and Henrich 2011). The ability to engage in participative tasks, and

therefore to understand and enact social expectations, is a core mechanism of this cultural ecology (Tomasello et al. 2005; Tomasello and Moll 2010). In other words, an integral part of how I experience my field of affordances and the success of my engagement with that field, is the relationships of those around me engaging in similar tasks. The way we reconstruct, enact, and participate in building social expectation has been accounted for as the construction of a sociocultural and material niche, described as “regimes of attention”¹ (Ramstead, Veissière, and Kirmayer 2016; Veissière et al. 2020; Hipólito and van Es 2022; Constant et al. 2019). In this account, worldly solicitations overarching my immediate attentional profile is constructive of a shared regime of attention, a mode of allocating directing our attention toward material and culturally relevant cues which are embedded with culturally specific expectations.

In principle, one could account for this process of internalisation and externalisation of sociocultural normativity in many different ways. For example, many authors have provided a classically enactivist account of sociocultural normativity (Heras-Escribano, Noble, and Pinedo 2015; E. Di Paolo, Lawler, and Vaccari 2023; E. A. Di Paolo and De Jaegher 2021). We would however argue this framework is ill equipped to account for both the phenomenology and mechanism of sociocultural normativity. Indeed, any claim of *bona fide* downward causation from «the landscape of sociocultural affordances» toward any individual would at least entail that individuals largely share an estimation of the normativity at hand, drawing from (Flack 2017)’s argument. The direct engagement of embodied and situated agents with their world does not afford any direct mechanism to build such a consensus. What does, however, is the systematic attempt by agents to understand and predict the expectations of others. This is the core of the “regime of attention” account we borrow here, which is a derivation of a radical strand of predictive processing called the Active Inference framework. If embedded normativity constrains action, it can be thought of as extrinsically regulating the intrinsic metabolic and modulatory normativity of an autonomous agent, and organizing the way human agents acquire norms. That includes preferences, tastes (i.e., their regime of attention) and perceptual profile to orient action by incorporating imitation on modes of embodiment. What becomes relevant to an individual also specifies a community of people, embedded within a ‘web of social relationships’ in a cultural niche. The positive or negative valence, (i.e.; success or failure) of my engagement with immediate solicitations is contingent on both my field of affordances plus the perceived expectations of “others like me” (Veissière et al. 2020). That means a circular

¹ A regime of attention is, under Active Inference, a specialized term referring to all of the factors that dictate how an agent selectively samples their world. We sample that which is most salient, in the sense that a salient cue affords an epistemic action (such as an eye saccade) expectedly providing the agent with information gain for belief updating. What is most salient for a given task is a result of a range of factors including the internal state of the system (interoception, temporally-nested goal structures, immediate needs), contextual factors and external states of the environment (including cultural and social norms and expectations). See Parr and Friston (2019) for a specific discussion of the relation between attention and salience.

yet constructive relationship by which individuals negotiate the valence of environmental cues, the social scripts that are associated of certain situations, and more generally construct the embedded normativity of their shared niche. Throughout this piece, we will use the qualificative “sociocultural” to describe this pattern of social and cultural embedding. Given this notation, we can claim that humans typically experience embedded normativity as a sociocultural field of affordances, strictly speaking.

Phenomenologically speaking, it means that our perception of the world around us and of the possibility we have to engage with is constrained by the cultural norms and scripts that we have integrated throughout our lives. Agents are continuously directed to develop specific body skills and attentional profiles, initially by their caretakers, from an early age, later by their peers (Hipólito and van Es 2022). For instance, being oriented towards specific goals as children, walking towards parents, smiling when it is appropriate to smile or matching shapes and colors, get reinforced or destimulated. Such orientation continues to take place by peer relationship and contributes in adding valence to concrete (i.e., physical and situated) experiences, happening and tolerable in specific environments, in specific timelines. That conveys to an agent a sense of how well they are performing. Critically, those patterns are (in part) mediated by what we observe as acting on our material niche, without any reflexive awareness of the cultural patterns at play. Becoming sensitive to material cues can be understood

in terms of organism-environment attunement. That is to say, given the socio-material and historical organism that one is, the habits one has formed and so on, one develops certain sensitivities to the environment it is in. (Hipólito and van Es 2022, pg 2)

Those sensitivities elicit and constrain the landscape of relationships, embedding and enforcing the set of norms in which the relevant relations are structured; more importantly, it brings forth relevant and salient modes of behaving throughout one’s life. Those are the relationships that direct an agent towards what requires attention at that time and what can (or should) be ignored in their socially constructed environment. The continuous aspect of situated and embedded normativity in socially shaped environments provide concrete cues patterning action and perception in such a way there is no scale of behavior never purely decoupled from cultural norms, up to the very dynamics of basic perception (E. Di Paolo, Lawler, and Vaccari 2023). Said differently, it embeds the normative relations that socially constraint agentive behavior at all levels. Sociocultural practices are continuously cued by embedded normativity eliciting appropriate action that involves following the

“tracks” laid down in local environments by others, or following the norms and rules presented through by institutions, without engaging with others’ interiority (Veissière 2020, pg 8).

In other words, modes of engagement and practices are contextual and encoded on the material environment, and can be construed as prior knowledge. The ‘track laid by others’

function as organization cues of a broader and more stable structure. The question we have to address here, given our goal to leverage this account in concrete insight for the nature of collective lifeforms and the methodology of cognitive archaeology, is to what extent those tracks (i.e. the shared material niche) embed information that is recoverable much later by agents that did not share a sociocultural niche with the participants. This is where we will turn to the description of how sociocultural forms of life “encode” information in the material niche, through the material cues that scaffold the development of sociocultural normativity.

Encoding Normativity: Landscape Construction as Sociocultural Autonomy

Given the account of the cognitive dynamics of materially embedded normativity we have just presented, we will now turn to investigating how social systems can encode expectations over individual or collective behavior (i.e., norms) within the material niche. However, we should first clarify what we mean by “encoding” and “social systems”. The notion of “code”, as an analogy to a computer code carrying a well-specified set of operations, has been repeatedly and rightfully criticized as a model of genetic information (Pigliucci 2010) as well as cognitive meaning (Brette 2019). Indeed, biological and cognitive systems do not contain a set of unambiguous instructions that fully would explain their behavior. We do not mean to claim that social systems are somehow different. Rather, our notion of encoding refers in a more fundamental sense to coding theory, in which it refers to a process of steps through which information can be transcribed and transmitted. As it will shortly appear, our perspective is quite radically incompatible with a computational perspective. To put it another way, “encoding” carries the intuition that if we understand the logic through which a message was generated, we are likely to infer its meaning. An instance of this intuition applies here: if we understand the logic through which an archaeological landscape was generated, we are more likely to accurately infer the system of norms it embedded by assessing the traces it left behind.

Let us ask, then, what kind of logic underpins the construction of landscapes by social systems. Luckily for us, much of the heavy lifting is done via the work of defining biological organization, by (Montévil and Mossio 2015) as closure of constraints. Constraints are understood here to be “contingent causes, exerted by specific structures or dynamics, which reduce the degrees of freedom of the system on which they act” while “remain[ing] unaffected by them”. Closure, in turn, is the property of a system of constraints in which each element participates to produce other constraints within the system, while being itself produced by other constraints within the system. As an illustration, we could think of how the mechanical structure of our vascular system enables blood flow and therefore the broader activity of our metabolism, which itself maintains the integrity of our vascular system through the continuous replacement of the cells which constitute it.

Understood statistically, the concept of a “constraint” can unambiguously be extended to the role of material or

sociocultural landscapes in driving human attention and behavior. It organizes and supports the mechanism by which social cultural landscapes drive and shape behavior and attention profiles materially. Thus, the role of any given constraint is contingent on, while participating to produce, a broader social organization. For example, a functional road system enables regional trade (which plays a critical role in the economic metabolism of connected cities), while necessitating an active maintenance which is reliant on that functioning economic metabolism. Social systems (at least, at certain scales) can therefore be understood as forms of life properly speaking, which enacts autonomy through the means of sociocultural rather than biological processes. We call those sociocultural lifeforms, and their self-creative property sociocultural autonomy. Importantly, the material landscapes they produce routinely constrain the behavior of their constituent individuals in functionally relevant ways, and therefore participate in the broader autonomous organization. But how exactly can material landscapes encode anything about the structure of the broader system?

A form of encoding is entailed by the constraint-closure relationship. Indeed, any individual constraint is produced by the broader organization it is part of, and then participates to produce the broader organization. A constraint over the space of possible system’s states (i.e. information) is therefore embedded within the structure of another, system specific constraint, which works to limit the space of possible system states at a later time. In other words, the constraint, through its constructive role, strictly speaking encodes the limit to itself at a later time. Given that complex relationship, we will consider that constraints embedded within the material landscape “encode” something about the broader organization they are part of, and turn to the question of how the material landscape can embed social constraints.

We can define two broad categories of constraint embedding within a material landscape: structural embedding, and semantic embedding. Structural embedding corresponds to situations where the material structure of the landscape is what constrains agents within the social system. For example, the topology of a road network may constrain travelers and trade networks to gravitate around certain cities, “encoding” their regional dominance. Semantic embedding corresponds to situations where what a situated agent can infer from the material structure of the landscape is what constrains agents within the social system. For example, the grandiose architecture and central position of temples within ancient Mesopotamian cities may convey in a single glance the dominant role of the priest class in social organization (see Thomas (2012) for an account of the urbanization dynamics in ancient Mesopotamia).

The reader may object that nothing justifies a clear dichotomy between structural and semantic embedding. Indeed, structural and semantic embedding tend to play hand in hand in encoding social constraints - especially given that agents have an intuitive understanding of the dynamics involved. For example, the dominance of nearby City-States may be structurally embedded in a landscape by the presence of wheat or rice fields. Indeed, cereal monoculture is an overall terrible deal for an individual farmer, but is necessary to surplus extraction and the maintenance of an urban

population (Scott 2017). But to an agent who knows what agricultural societies are like, this paysage is a telltale sign of (i.e. semantically embeds) City-State dominance. More generally, structural embedding produces a landscape that affords or constrains certain activities, and an agent's ability to recognize this pattern of constraints and affordances entail a form of semantic embedding.

Rather than capturing different features of the landscape, this dichotomy is meant to capture two complementary mechanisms by which the landscape shapes human behavior. When the landscape shapes normativity by physically preventing or allowing certain kinds of interactions, we call that structural embedding. When the landscape shapes behavior by signaling to the agent what is expected of them, we call that semantic embedding. Because both forms of embedding constrain behavior toward specific patterns, both can be understood as instances of embedded normativity. And because both prerequisite that the agent reconstruct the normative expectations embedded in the landscape, both can be understood as processes of encoding.

The duality of structural and semantic embedding provides us with a limited, although critically important, window in the experience of the human evolving within a given landscape. As discussed above, sociocultural lifeforms exist as a system of constraints over human behavior. And such constraints exist as instances of materially and socially embedded normativity, and as such are contingent on the ability of agents to reconstruct and enact them. This entails that when sociocultural lifeforms produce their constitutive constraints, they do so in a way that is transparent to the individual humans who enact them. Moreover, this is a constitutive aspect of what it means to be a sociocultural lifeform, rather than a side property. By construction, any constraint, within any sociocultural lifeform, must be legible to at least some of its constituent individuals.

Earlier research discussed how such instances of normative embedding served as the background of sociocultural autonomy, and what it means for the relation between biological organization and cognition (Guénin—Carlut 2022). Our proposition adds to the idea that normativity may be embedded within the material landscape itself, and that constitutes a shared language between the social organization and constitutive individuals. Although it is perhaps counter-intuitive, the notion that sociocultural lifeforms and individual humans may share a language is all but entailed by the very notion of semantic embedding. Indeed, this mechanism relies on the ability for humans to accurately reconstruct norms that are embedded in the material landscape. In other words, norms that are embedded in the material landscape must be successfully decoded to meaningfully exist as social constraints.

The ability for individual humans to decode the norms embedded within their material niche, or more specifically the ability of social organization to encode social constraints within this niche, is well substantiated by the historical records. Indeed, we have access to many intentional attempts by State societies to alter the material landscapes in which their constituent individuals lived to transfer them specific norms. For example, the architecture and urbanism of Brasília was explicitly designed to implement a modernist perspective

over an ideal society (Scott 2020, chap. 4). The geometric and standardized design of both buildings and urban plan, the tall figure of the skyscraper, the strict separation of residence, work, and leisure zones all signify (and, more or less indirectly, enforce) the prevalence of a rational, legible social order with regard to any individual activity or aspirations. The architecture of factories inspired from “scientific” management may provide another, more direct instance of the same logic: social organizations encode norms within material landscapes and individuals decode those norms to enact the constraints which constitute the social organization.

Although we did not discuss here in detail the formalism underlying our proposition, we did minimally justify the notion that normative embedding within material landscapes may constitute an information channel between “sociocultural lifeforms” and the individual humans that constitute them. We must insist that this claim must be understood in a strictly literal sense, although only the case of semantic embedding corresponds to the scenario of consensual communication typically studied in information theory (while the mechanism of structural embedding is more reminiscent of physical causation). Given the existence of this information channel, we will switch perspectives and ask whether and how an archaeologist may intercept and decode the messages embedded within material landscapes.

Decoding Normativity: Material Landscapes as Proxies for Human Cognition

Cognitive archaeology, by construction, aims to reconstruct an image of the cognition of ancient humans through the tools of archaeology (Coolidge and Wynn 2016). As we noted in the introduction, this requires that the discipline infers cognitive traits from elements of material culture only, which is a daunting task. Coolidge and Wynn (2016) state that the only way that science can access the minds of prehistoric actors proceeds as follows: artifacts allow to infer the technical process that produced them, technical processes allow to infer underlying knowledge, which in turn allow to infer their cognitive prerequisite. They admit that this process is challenging, and we would add that any grip we get onto prehistoric cognition from this methodology is somewhat frail as it is vulnerable to compounded imprecisions in three distinct steps of inference.

The encoding of sociocultural constraints within the material landscape we have framed above provides a new, more direct way to infer the architecture of ancient human minds. First, constraints constitute properly speaking the driver of the “flow” of social organization, and the material landscape therefore participates in its cognitive dynamics in the same sense the body does in individual humans (Guénin—Carlut 2022). Second, the sociocultural landscape - including its material dimension - constitutes an extension of human cognition, in the sense that its traits become embedded in the “normal” processes by which we understand and manipulate our world (Constant et al. 2019; Veissière et al. 2020). In other words, when we study archaeological landscapes, we do not only study the context of ancient human cognition. The patterns we study are constitutive elements of sociocultural cognitive modes, which happen to be imprinted in material

culture. Let us look in more detail at how this account can meaningfully be leveraged for insight into ancient human cognition.

Recently, cognitive archaeologists working at the intersection of extended cognition and Active Inference have started investigating the embedding of social norms into material culture. More specifically, Criado-Boado et al. (2019) measured a correlation between social hierarchy and vertical patterns in pottery decoration, and intuited that those traits co-evolved due to their common grounding on (and reinforcement by) a vertical patterning of visual attention. Constant et al. (2020) later formalized this intuition by developing a computational model of visual attention patterning around a task where computational agents must recognize archaeological patterns similar to those documented in the previous article. Let us reflect on what Criado-Boado et al. (2019)'s hypothesis would mean, were it to be properly verified and validated. Vertical patterns would not simply be a sign that the archaeological culture studied was capable of understanding and producing verticality, as under Coolidge and Wynn (2016)'s model of inference. They would constitute, properly speaking, a constraint over the flow of human attention, produced by (and helping produce) a more general logic of verticality in human relations.

To speak informally, the framework of embedded normativity enables us to understand material culture as the fossil of Wittgenstenian forms of life. They constitute a snapshot of unfolding social relations and activity, as enacted by ancient social organizations. For example, wheat fields or monumental architecture would not be considered an external landscape bearing witness to a relatively hierarchical society, whose features are either causes or consequences of the aforementioned society and its activity. They would be constituent elements of such a society, and whichever remains we can observe are to be understood as remains of that society as an individuated entity. In other words, focusing on the embedding of norms within archaeological landscapes shifts the target of inference in cognitive archaeology from the abstract capacity of individual minds to the cognitive patterns concretely enacted by a specific sociocultural system within a specific archaeological era.

To be clear, we do not claim that the present account affords a clear and straightforward picture of how to "read" ancient human cognition or social organization in archaeological landscapes. Indeed, a core element of our account of sociocultural organization is that any individual constraint is only meaningful in the context of the broader system. By construction, the causal efficiency of embedded normativity resides in its perception and enaction by the agents evolving in those landscapes. Therefore, a social organization which equips individual agents with the adequate priors to understand and enact a given constraint is necessary to give it meaning. For example, a red light at a road intersection is embedded with the meaning that one must stop its course before an imaginary line at the level of the light, and wait for the light to go green before taking it back. Consequently, inference over social constraints are heavily constrained by our knowledge regarding the social dynamics of the broader system, and most importantly the way they are inscribed within individual experience.

Although we cannot hope to definitely close this interpretation gap, we can hope to leverage the Active Inference framework to build a bridge between the social constraints of past societies and their material remains. The central tool which affords that demarch is the Active Inference account of neurophenomenology, as formalized in (Ramstead et al. 2021). In essence, this theory entails that the experience of cognitive agent is generated by a set of prior expectations, which correspond in a meaningful sense to the probability distribution of their trajectories in the agent-environment space. Consequently, statistical constraints over behavior can be inferred from the experience of individual agents within a system, and vice-versa. If we can reconstruct, to some extent, what it is like to be an agent evolving within a given sociocultural landscape, we can approximately reconstruct the dynamical properties of the sociocultural landscape itself. This duality between individual experience as an encultured agent and the flow of social organization is a central feature of the present account, which we aim to build from our account of cognitive archaeology.

Let us turn from the study of vertical patterns by Criado-Boado et al. (2019) and toward the case study of ritual activity. It is largely admitted that participative activities enforcing a fine-tuned synchronization of embodied experience, such as dancing and music, has played a central role in the evolution of human sociality (Shilton et al. 2020; Savage et al. 2021). Additionally, it seems that those activities became embedded with material and gestural symbolism to broadcast and strengthen norms during the Upper Paleolithic, for example through the crucial ritual of burial. This provided a precursor to the evolution of what we understand today as religion (Sterelny 2018; 2020), and was a central part of the transition toward behavioral modernity (Nowell 2010). A large literature has focused on what determines the evolution of religious belief (see for example (Norenzayan, Shariff, and Gervais 2009; Norenzayan et al. 2016), while relatively little attention has been granted to the causal efficacy of ritual. Works that did investigate the cognitive role of ritual were generally focused on articulating a general typology of rituals and their mechanisms (Whitehouse and Lanman 2014; Atkinson and Whitehouse 2011) with few or no attention to how specific rituals may participate in the construction of cultural representations or norms. Works that did model specific rituals with the intent of explaining their functional role have bypassed the underlying cognitive dynamics entirely, by presupposing the behavioral effect of participation in rituals (Froese and Manzanilla 2018; Froese, Gershenson, and Manzanilla 2014). To the best of our knowledge, no simulation or theoretical works have reconstructed how a group of cognitive agents may experience ritual activity, and how this experience may shape the constraints of their behavior outside ritual.

The relevance of a generative model of cognitive agency equipped with a natural model of representation and phenomenology, such as Active Inference, is straightforward here. A given form of ritual activity may be reconstructed *in silico*, or a given assembly of agents may be allowed to self-organize within a space of possible ritual forms. In both cases, the model of learning afforded by Active Inference enables the modeling of semantic transfer between ritual activities and

social life, or in other words how social organization shapes ritual morphospace and reciprocally. Even from our removed armchair perspective, with adequate data we can infer “what it is like” to participate in a given ritual activity, or in other words how this ritual activity constrains the flow of attention experienced by attendees. From there, we can represent how ritual shapes the social constraints enacted by the relevant social group, and abstract entirely the perspective of individual agents. In other words, we can focus on the patterns of attention and normativity that are embedded within the ritual, and on their role within a broader social organization.

Although tuned to the study of ritual, this general strategy may be applied to the study of archaeological landscape without loss of information (or with no significant loss). These considerations provide a ground for cautious optimism regarding the possibility of decoding normative fields of affordances from the archaeological landscape we have access to. In and of itself, the concept of embedded normativity enables us to circumvent entirely the question of individual cognitive capacities, and rather focus on culturally enacted systems of constraints as they are imprinted on the material niche. Admittedly, we are far away from a robust computational methodology for inferring directly normative landscapes from material ones, and we doubt there will ever be one. However, comparatively modest development in the field of computational phenomenology would enable us to greatly advance our toolkit of inference, by reconstructing what it is like to evolve in a given archaeological landscape and what systems of norms are viable given this experience. We conjecture that such a modeling framework, in effect a decoder for embedded normativity, will be developed within our lifetime.

Conclusion

In the present article, we have proposed a formally grounded account of how normativity is embedded in the human niche, and derived arguments about the dynamics and study of material niche construction. In and of itself, embedded normativity derives from the deep relation between the subjective experience of agents and the exercise of the intentionality, as exposed in recent research in computational phenomenology (Bruineberg and Rietveld 2014; Bruineberg, Chemero, and Rietveld 2019). As agents experience the world as a landscape of affordances of action, “neutral” environmental features come to be read as bearing an intrinsic normative and emotional load. Given this, modulating the attention of humans means modulating the exercise of their agency (and vice versa), affording the collaborative construction of rich normative and phenomenal landscapes by human societies (Veissière et al. 2020; Guénin--Carlut 2022a). Importantly, this scheme entails that environmental patterns carry implicit normative expectations about how agents’ attention should flow, and therefore (indirectly) how they should behave.

Given these considerations, we may consider a material landscape as a system of constraints over how human agents would behave locally. Framing embedded normativity in the language of constraints allows us to make two crucial novel arguments. First, that material landscapes are indeed carriers

of normativity, properly speaking. Second, that they are constitutive elements of social forms of life, here again properly speaking. Indeed, Montévil and Mossio (2015) allows us to identify biological organization as constraint closure, i.e. the existence of a set of constraints able to canalize metabolism so as to reproduce itself. Importantly, because the constraints must be enacted by the agents who constitute a sociocultural lifeform, the material landscape must robustly elicit certain behavior, either by mechanically enforcing them (structural embedding) or by signifying that they are expected (semantic embedding). This entails the existence of a communication between the sociocultural lifeform itself and its constitutive agents, mediated through the material landscape itself.

This allows us to frame the embedding of normativity in the material niche as the encoding of constraints within the environment, which individual agents must decode - and that we may be able to decode as well if we understand its logic. The most straightforward way to do so would be to use the growing field of computational neurophenomenology to simulate the experience of situated, embodied agents within the target archaeological landscape. Indeed, we posit that embedded normativity reduces to the modulation of attention flows by an agent’s environment. The dynamical constraints over those flows would therefore be, by construction, the constraints constituting the sociocultural lifeforms which have inhabited and constructed the target landscape. Ultimately, the relevant information existing in archaeological landscapes may have been erased, or may be irreducibly tied to the lost sociocultural practices in which it was embedded. The relevance and validity of the program presented here heavily depends on many fundamental and technical questions surrounding the nature of life, and in particular of biological information. We do however take the present work as a proof of principle that the cognitive archaeology of sociocultural lifeforms is a coherent program, as well as a very basic outline of its ontology and methodology.

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