Synthese (2021) 198 (Suppl 1):S447–S460
https://doi.org/10.1007/s11229-019-02240-7

S.I.: RADICAL VIEWS ON COGNITION

On the spatiotemporal extensiveness of sense-making: ultrafast cognition and the historicity of normativity

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Received: 31 August 2018 / Accepted: 6 May 2019 / Published online: 10 May 2019

Abstract

The enactive approach conceives of cognition as acts of sense-making. A requirement of sense-making is adaptivity, i.e., the agent's capacity to actively monitor and regulate its own trajectories with respect to its viability constraints. However, there are examples of sense-making, known as ultrafast cognition, that occur faster than the time physiologically required for the organism to centrally monitor and regulate movements, for example, via long-range neural feedback mechanisms. These examples open a clarificatory challenge for the enactive approach with respect to how to operationalize monitoring and regulation, and with respect to the temporal scale of sense-making, which has traditionally been limited to the here-and-now in accordance with the axiom of structural determinism. We explore possible responses to this challenge and suggest that this axiom should be explicitly rejected, in particular, we suggest that adaptivity is a property of organism–environment interactions over a time span that includes both present and past conditions. Ultrafast performances are thus no longer a challenge for the enactive approach, because the constitutive basis of their normativity is spatiotemporally extensive. This is in agreement with recent developments in different varieties of enactivism, which all converge toward assigning a constitutive role to an agent's history of interactions.

Keywords Ultrafast cognition · Adaptivity · Sense-making · Normativity · 4E cognition · Enactivism · Structural determinism

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1 Introduction

Enactivism was launched as a fundamental theoretical alternative for cognitive science with the ambition to provide a more coherent scientific account of human experience compared to the existing theoretical framework based on the computational theory of mind (Varela et al. 1991). A key conceptual move involved the replacement of the representational approach to cognition, which treats it as essentially information processing, with a dynamical approach to cognition, in which it is primarily seen in terms of patterns of agent-environment interaction. Such interactions are not neutral; they proceed in service of the agent's meaningful engagement with the world, constituting a perspective such that encounters are not simply undergone but appear significant to the agent (Varela 1992, 1997). They have come to be referred to as *sense-making* processes to distinguish them from traditional information-processing accounts of cognition (Weber and Varela 2002).

Enactivism understands cognitive agents as self-producing (autopoietic) and adaptive systems. Self-production provides the core foundation of agents' intentional relationship with the world (Thompson 2007): the world is meaningful in terms of what allows or threatens the agent's purpose of maintaining its identity (Weber and Varela 2002). While self-production explains the basic normativity of agent-environment interaction, adaptivity, as proposed by Di Paolo (2005), explains how agents can enact their perspective in a suitably differentiated manner. In Di Paolo's words:

> A careful analysis of sense-making shows that different properties of adaptivity (self-monitoring, control of internal regulation, and control of external exchanges) are implied by assuming that organisms have a meaningful perspective on their world, hence this property is not simply an addendum but is essential (together with autopoiesis) to naturalize sense-making. (Di Paolo 2005 p. 430)

More specifically, the claim is that "adaptivity reflects the organism's capability—necessary for sense-making—of evaluating the needs and expanding the means towards that purpose" (Di Paolo 2005, p. 445). Crucially, adaptivity implies that monitoring and regulation are conceptually constitutive moments of sense-making.

There is a worry that the appeal to processes of evaluation or monitoring and control or regulation of an organism's activity might set the bar too high for basic forms of sense-making. There is a temptation to interpret these processes in a centralized manner, such that something inside of the agent is doing the monitoring and controlling, which would make the enactive approach vulnerable to the same charges of homuncularism that it leverages against the computational theory of mind. In other words, it is one thing to claim, uncontroversially, that we sometimes monitor and control our behavior, for example, while carefully carrying a cup full of hot coffee without spilling its contents over the office floor. But it is quite another thing to claim that functionally similar processes are occurring inside of us as we realize this balancing act, or to even make these processes into an essential condition of all instances of sense-making, including of bacterial chemotaxis, to take just one popular example.

Indeed, there are cases of adaptive behavior that demonstrably do not involve any dedicated mechanisms of monitoring and regulation. This is illustrated by a continuous-time spatial model of molecular concentration dynamics, in which a self-

producing protocell emerges that is capable of adapting to some perturbations by spontaneously reorganizing its internal structure (Agmon et al. 2015). An analysis of these minimal adaptive transitions revealed that they emerge from distributed spatial processes. As monitoring and regulation can be emergent properties of spatially distributed processes, enactive adaptivity does not have to be understood in homuncular terms.

From the early works of enactivism, it has been recognized that the history of agent-environment interactions plays a role in sense-making; in Varela et al.'s words, "cognition is (…) the enactment of a world and a mind on the basis of a history of the variety of actions that a being in the world performs" (1991, p. 9). Inspired by autopoietic theory, the enactive approach has understood the role of history as a causal one. This is captured by "the axiom of structural determinism", which constrains the temporal extension of adaptive processes such that "changes of state in a system always operate in the present as a result of its current structure and are not determined by external agents or contextual conditions" (Di Paolo 2005, p. 434). Past interactions are part of contextual conditions; thus, although they causally determine the current structure of the system, they do not determine how current agent-environment interactions unfold in the present moment.

If the enactive approach is right, we may be justified in asking how exactly the axiom of structural determinism holds for adaptive processes that unfold in time. In this paper, we put this concern in sharper relief by considering a body of research in psychology, namely studies of so-called ultrafast cognition. This notion refers to meaningful behavior that happens too quickly for information processing in the brain to play a role in controlling how the behavior unfolds. The consensus is that the agent is poised to be triggered by its circumstances in such a way that it will automatically converge into the right behavioral attractor. Monitoring and regulation are seen then as emergent properties of the whole interaction. But if this account is on the right track, it becomes unclear how, within the enactive approach, monitoring and regulation could result from the current structure of the system and not be normatively constituted by the historical conditions of the task as a whole, in other words, it is unclear how the axiom of structural determinism could still hold in ultrafast cognition.

We explore possible solutions to the clarificatory challenge that ultrafast cognition poses, and we suggest that adaptive processes emerge from organism–environment interactions over a time span that includes both present and past conditions. Thus, intentions and sensitivities arising from the history of interactions of an organism set up its anticipatory states and help to normatively regulate concurrent aspects of skillful engagement in the world. In that sense, we suggest that monitoring and regulation can be emergent properties of processes extensive not only in space but also in time. This idea is explicitly rejected by the axiom of structural determinism of classical autopoietic theory. However, we believe that the concept of adaptivity has evolved from its first formulation so as to acknowledge now the normative role of the organism's history of interactions thereby implicitly rejecting the axiom of structural determinism. By making this change explicit, we invite enactivism to take seriously the idea that mind must also be conceived of as temporally extensive in addition to being spatially extensive.

In the second section, we start by briefly summarizing the enactive framework. We focus on its influential proposal that sense-making is grounded in adaptivity, for which monitoring and regulation are essential and in which the axiom of structural determinism holds. Then, in the third section, we consider two examples of ultrafast cognition which, we argue in the fourth section, pose a challenge for the requirement of adaptivity in the classical enactive theory of sense-making. In the fifth section, we discuss three possible solutions to this challenge, and conclude, in the last section, by suggesting a conciliatory solution that, by rejecting the axiom of structural determinism, brings together two of these possibilities which have so far been developed relatively independently, namely, the enactive approach and its radical counterpart.

2 The enactive approach to sense-making

In the enactive approach, a cognitive agent is defined as an autopoietic and adaptive system. An autopoietic system is an autonomous system which has two interconnected features: It is (1) a system that continually produces itself materially and/or dynamically under precarious conditions, and (2) in this way it establishes a concerned point of view on its environment (Weber and Varela 2002). The first feature means that its organization is such that its ongoing operations continually generate its own precarious identity as the kind of system it is. Precariousness means that it has to be open to interact with the environment to obtain the matter and energy it needs to keep existing. This brings us to the second feature of autonomous systems: The conditions of these interactions are asymmetrical, as they are generated by the system which is seeking to maintain itself, and, in that sense, the interactions it brings forth are intrinsically purposeful from the perspective of the system. Whatever threatens its process of identity generation, be it its encounters with the environment or its internal dynamics, becomes significant to the system (Weber and Varela 2002).

As we mentioned in the introduction, for Di Paolo (2005) being autonomous is a necessary but not sufficient condition for this kind of sense-making. The autonomous system in itself would not be capable of recognizing potential threats in the environment or in its own dynamics; instead everything is good for it as long as it does not destroy it. Di Paolo's concept of adaptivity aims to tackle this issue. An adaptive system is capable of monitoring how the perturbations it encounters shape its trajectory within the range of non-fatal events, i.e., its domain of viability, and it is capable of regulating itself accordingly. Thus,

> [t]he capacity for adaptive responses entails two co-defined moments. One is the moment of discrimination or differentiation of the virtual tendencies in the current situation that may have an effect on the viability of the system. The other moment involves the system inducing some change such that these virtual tendencies are modified toward sustaining viability over time (Di Paolo et al. 2017, p. 136).

These moments do not occur in succession but co-occur in sense-making. Moreover, there are two conditions for tendencies and possible actions to be distinguished and monitored. First, they result from the system's current structure which determines

what is currently relevant for it. This means that agents are sensitive to and able to regulate only what is present in the here and now, thus, their adaptive changes are not determined by external agents or historical contextual conditions. This condition is known as the axiom of structural determinism. Second, the counteracting mechanisms that monitoring and regulation involve differ in degree or kind as long as they imply different regulatory changes in the system to be distinguished by the agent (Di Paolo 2005, p. 439). Hence, monitoring is defined in terms of possible regulations, and in this sense the relationship of sense-making can be properly established: "[w]hat is meaningful is that which the agent is sensitive to and adaptively capable of regulating" (Di Paolo et al. 2017, p. 179). These concepts are meant to apply to all living beings, whether they possess a nervous system or not.

Both definitions of autonomy and adaptivity have been adjusted to do justice to the added complexity of organisms with a nervous system, i.e., animals. Di Paolo et al. (2017) have recently proposed to understand them as applying to the animal-environment interaction, which in turn is understood in terms of sensorimotor schemes. Their proposal captures the various layers of normativity at play in the human–environment interaction, which will later allow us to understand how ultrafast performances are possible and the various layers of normativity at play in them.

Sensorimotor schemes describe the agent-environment interaction of animals, that is, perception and action. Perception and action are codependent because, on the one hand, action is perceptually guided and, on the other, perception is guided by action. They are both understood as regularities that occur in dynamical, closed and self-organizing sensorimotor loops. Di Paolo et al.'s notion of sensorimotor scheme designates precisely these loops and comprises all the bodily and environmental structures that support perceiving and carrying out a specific action. For example, under this definition, grabbing a cup is a sensorimotor scheme than involves the whole coordination of body and environment.

Sensorimotor schemes self-organize in autonomous and adaptive networks that allow a cognitive system to carry out specific activities by transitioning from one scheme to another. These networks are successions of schemes organized such that carrying out a particular scheme allows the agent to carry out the next—e.g., grabbing a cup allows the agent to sip a drink–, and the whole succession makes her carry out an activity—e.g., having coffee with a friend.

The normativity under which schemes organize in a network is imposed by its current internal organization and the particular situation in which it is carried out. On the one hand, the internal organization of a network is determined by the goals proper to the activity that the network allows the agent to carry out. In drinking coffee, the internal organization of the series of schemes of grabbing the cup, sipping, and putting the cup back, is normatively determined by their aptness to make the agent actually drink coffee, to continue interacting with her friend, etc. On the other hand, the sensorimotor network should be sensitive to the particular context in which both environmental and organismic conditions play a role. For example, I may pick up the cup to drink because my body is dehydrated, and someone is about to pour me a drink; not only would it be impolite not to receive it in this situation, but it will also allow me to bring the drink to my mouth and actually drink it. Following this normativity requires previous and continuous monitoring and regulation of how the

network is being carried out in the circumstances: whether it follows the internal norms of the activity and whether it goes towards achieving the goals proper to the activity in those circumstances. The required monitoring and regulation of enacting networks of sensorimotor schemes captures the requirement of adaptive regulation.

3 Ultrafast cognition

Now we consider two examples of ultrafast cognition: perturbation tasks and go/no-go tasks. In both tasks, cognitive performances occur faster than the time physiologically required to transmit information to the brain and to further process it there. Despite the speed, subjects' responses are reliable, that is, they are correct in a significant rate, and subjects feel as the agents of these cognitive performances. This point will allow us to reveal in the next section a tension between the axiom of structural determinism and the monitoring and regulation requirement of sense-making in these ultrafast examples of sense-making, a tension that has hitherto remained implicit.

In go/no-go tasks participants are asked to respond when a target is present and to not respond when the target is absent. One of the most prominent examples is the experiment conducted by Macé et al. (2009) in which photographs of natural scenes were presented to participants for 26 ms each. In one of the tasks, participants were asked to release the button if an animal was present in the scene and to keep pressing the button otherwise. After 1 s of not releasing the button, the response was considered a no-go. The fastest response recorded was 260 ms for scenes in which the animal was a dog, and the average time of reliable responses was 390 ms. Other experiments have revealed that the gist of pictures can be extracted in fewer than 200 ms when performing at the fastest speed (Greene and Oliva 2009; Grill-Spector and Kanwisher 2005; Wallot and van Orden 2012, p. 4). This is significantly faster than the 1 s timescale associated with completed cognitive acts, including perceptuo-motor behavior, that are integrated via large-scale neural synchrony in the brain (Varela 1999).

In perturbation tasks, subjects' performances are slightly disturbed in order to test how these small perturbations are overcome. Saccades (Kirchner and Thorpe 2006; Altmann 2010), gait (Weerdesteyn et al. 2004), arm movements for indicating word recognition (Moreno et al. 2011), and other kinds of performances (Porter and Castellanos 1980; Kozhevnikov and Chistovich 1965) have been tested in this way. One of the most well-known perturbation tasks is the jaw perturbation experiments conducted by Kelso et al. (1984). Participants' jaws were slightly pulled downwards while they said either/baez/or/baeb/and their responses in tongue, upper and lower lip were observed. Participants did not know when the pull will occur. The experiment revealed that the compensation for each word differed: for/baez/, the compensation was mainly made by the tongue, while for/baep/, it came from the upper lip. Both compensations occurred within 5–10 ms, and the words were successfully pronounced.

These response times present a challenge for the traditional information processing explanation of cognitive performances. According to Wallot and van Orden (2012), the time left for information processing allow the spiking of too few neurons, so that they would create an overtly fragile representation. Moreover, even if the information was encoded by the order of neural firing and not its frequency, the complexity

of photographs of natural scenes makes it highly unlikely that the accuracy of the responses obtained could be explained by "single neurons connected in feedforward stands" (Ibid, p. 6). Therefore, these difficulties call for a different approach, one that appeals to the dynamic organization of the sensorimotor system.

Such an approach has been proposed by Kelso et al. (1984) and others, and adopted by Di Paolo et al. (2017). According to Kelso et al., the observed differences in compensation for each utterance support the hypothesis that they are produced by coordinative structures directed to the stable production of a particular meaningful action, rather than by standardized patterns of response as it would follow from completely programmed or fixed input–output loops (Ibid, p. 813). Coordinative structures coincide with the notion of sensorimotor scheme in the framework proposed by Di Paolo et al. (2017), who agree with Kelso et al., and further interpret the quick compensation as a "quick adaptive [therefore, meaningful] reaction to external perturbations" (ibid., p. 202).

Similarly, the fast responses observed in the go/no-go tasks discussed above are interpreted by Di Paolo et al. (2017) as the enactment of a sensorimotor scheme. In both cases, a set of sensorimotor schemes appropriate for the task in the given context is primed. "This poises the agent in an anticipative state rich in equally valid propensities (paths) to respond, all of which share a common end." (p. 201). In the case of the jaw perturbation experiment, the end was to produce each utterance, and in the case of the go/no-go experiment it was to release the button when the target was present. Being in such an anticipative state "is the intentional aspect of the emerging action. A slight change in circumstances (internal or external) then can be enough to break the system's symmetry and select one among the manifold of possible actions [sensorimotor schemes]. This is experienced as action initiation." (p. 201). In both cases, the agent is poised to produce a meaningful behavior in the particular circumstances.

4 Structural determinism and strong anticipation: a hitherto unrecognized tension

Ultrafast cognition examples showed that we can respond meaningfully without any need for higher-level deliberation, which speaks in favor of an embodied account of sense-making. If we accept the axiom of structural determinism, meaningful responses, including their adaptive and normative properties, must be constituted by the current structure of a system and not by its historical context. This should apply to ultrafast cognition too. However, it is not clear how monitoring and regulation play a role in what seems to be a merely reflective response that occurs in less than a second. This, then, opens the question of how to understand the concept of adaptivity in such short time scales. As we will see, the accepted enactive explanation of ultrafast cognition relies on the history of agent-environment interactions to account for the normative dimension of these quick responses, which reveals a tension between the classic enactive conception of history as playing a causal role and the seemingly constitutive role of history at ultrafast cognition.

Committing to a single relevant sensorimotor scheme does not require processing incoming information or explicit deliberation. As the agent is "already poised in a

critical anticipative state appropriate to the current context" (Di Paolo et al. 2017, p. 202), the selected scheme will be an appropriate and meaningful response to the current circumstances, it will be within a network of schemes that allow the agent to perform an action, and it will be experienced as such by the agent. Within this dynamical framework, ultrafast cognition can be explained: even without feedback, these kinds of adaptive performances are possible, because agents were already prepared to give a meaningful and appropriate response in the circumstances. In this case, "the stimulus acts as a trigger and not so much as bearing information that needs to be processed and decoded" (ibid., p. 225). These anticipative states are interpreted not as predictive modeling, but as an embodied attunement to a situation previously set up "by the integration of feedback, delays, and synergies into its overall dynamics" (ibid., p. 225).

The history of agent-environment coupling has transformed the agent such that it is poised by the environment to trigger the appearance of an attractor in its sensorimotor state space of possibilities into which it will simply fall and thereby realize the appropriate action. Thus, feedback is not required during ultrafast performances because a meaningful response was already selected out in the anticipative state. Moreover, most perturbations to the state trajectory of this performance will not be sufficient to kick the sensorimotor system out of this attractor's basin of attraction, which means that it will spontaneously compensate for the deviation without any need for feedback or extra processing. In other words, "[strong anticipation] is purely reactive at some level of analysis" (Stepp and Turvey 2010, p. 156). Yet it is not a mere mindless reflex.

Despite the absence of any role for feedback during the adaptive performance of the behavior, participants are engaged in sense-making. Their ultrafast response follows various kinds of normativity. First, agents should correctly tell whether there is, say, a dog in the screen, which means that they should make sense of what they see. Second, they should adopt the norms established by the experimental setting, that is, they should release a key and not shout 'dog!' or enact any other sensorimotor scheme when they see a dog in the screen. Third, they are guided by sociocultural factors that make them participate in the experiment in the first place, e.g., being stimulated by a monetary reward, by participating in a scientific experiment or by empirically testing their own hypothesis in themselves.

The enactive theory of sense-making predicts that these meaningful performances are monitored and regulated according to those norms. As we saw, the accepted explanation of falling into an equilibrium point attractor emphasizes the constitutive and normative role of the historical context. However, if adaptivity is subjected to the axiom of structural determinism, the very moment of falling into an equilibrium point should be determined by the current structure of the system and not by the historical context. The kind of determination at play should involve concurrent monitoring and regulation to count as a sense-making response. However, it is not clear how these could emerge or be operationalized in such fast response times, because there is not enough time for feedback or any other dedicated mechanism of monitoring and regulation to play a role. Thus, ultrafast cognition reveals a tension between the classical formulation of adaptivity that, by adopting the axiom of structural determinism, understands history as only having a causal role and the current working concept of adaptivity that emphasizes the constitutive role of the historical context.

5 Discussion

We now consider three possible ways of clarifying the role of history in ultrafast sense-making.

1. The first possibility is to accept that ultrafast performances are instances of sense-making and to account for adaptivity as ultrafast monitoring and regulation.

It could be argued that monitoring and regulation play a role in the millisecond time scale of unfolding ultrafast performances based on processes that do not require long-range feedback. It is possible that local feedback is at work, presumably involving the spinal cord or localized loops in the body. This could be provided by "control signals" that "can travel in all directions and across levels of organization without being channeled first through the ordered layers of a hierarchy" (Flament-Fultot 2016, p. 163), which could be enough for ultrafast monitoring and regulation. This possibility would need to be developed in more detail, yet it would be one way of securing a constitutive basis of normativity in the present moment, and it would make ultrafast cognition consistent with the axiom of structural determinism. On this view, the role of preceding agent-environment interactions would be purely causal, having the effect of ensuring that the system is poised such that it is able to respond adaptively in an ultrafast manner.

However, there are two considerations that suggest that ultrafast cognition could potentially be constituted over a longer time span: (1) The standardly accepted explanation of ultrafast cognition in sensorimotor terms, favored by Di Paolo et al. and others, relies heavily on the historical context, and (2) this temporal extensiveness would be more consistent with the need to appeal to the preceding interactions in order to be able to make sense of what the agent is doing during their ultrafast performance, such as that they decided to participate in a psychological study involving certain expectations. Even if these two considerations are not sufficient to completely discard this first possibility, they point toward a promising alternative possibility.

2. The second possibility is to deny that ultrafast performances are acts of sense-making and to consider them as part of an act of sense-making that unfolds over a longer time span.

A person performing a go/no-go task is certainly monitoring and regulating her activity during the course of the whole experiment, for example, by trying to follow the instructions, to do well on the task, and to keep the mind from wandering. So, perhaps, these ultrafast normative responses derive their sense from being embedded in these larger contexts and temporal scales. This second possibility is consistent with Di Paolo's conception of the temporal dimension of adaptivity. According to him,

> [an] adaptive event (or act) may be formed by the concatenation and parallel coordination of many other regulatory events, but there will be a point below which no further de-composition will be possible without losing the time-structure of the act. At that point what remains are raw processes. There is consequently a *minimum temporal granularity* in adaptivity. (2005, p. 444)

Ultrafast responses could be below the threshold of de-composition as they leave no time for parallel regulatory events to occur and coordinate. Instead, they may be

precisely one of these regulatory events or raw processes, and their significance, if any, may be only derived from being part of a sense-making act that unfolds in a longer temporal scale. Thus, an ultrafast response can be conceived of as an element of the temporal structure of a whole sense-making act, whose temporal duration extends beyond the ultrafast response itself.

Di Paolo characterizes the minimal temporal structure of a sense-making act as follows:

> Every adaptive regulation "is a structured event, with clearly defined phases of onset (the sensing of a negative tendency), acceleration (the activation of the adaptive mechanism), consummation (the overturning of the negative tendency) and cadence (the de-activation of the adaptive response)" (Ibid, p. 444).

As stated above, ultrafast responses occur after the agent is in an anticipatory state, which means that the agent is poised to respond. It is still underdetermined which of various possible sensorimotor schemes will be carried out, but the symmetry between these possibilities is broken when there is a slight change in circumstances. This anticipatory state could be understood within the temporal structure proposed by Di Paolo as the activation of the adaptive mechanism, that is, the acceleration phase, because in this state the agent becomes sensitive to the changes in circumstances and is ready to carry out the appropriate behavior given those changes (monitoring). In turn, an ultrafast performance, which was taken to be the meaningful behavior carried out once the symmetry was broken (Di Paolo et al. 2017, p. 201), can be understood as the consummation stage in which the negative tendency is overturned (regulation). The negative tendency in this case amounts to not responding appropriately and not having a good performance during the experiment.

But if this is the case, then enactive theory still has some work to do to explain how activities that in themselves require no monitoring nor regulation can derive their meaning from overarching processes of sense-making, given that, in their short temporality and in themselves, they are not instances of sense-making. Remember that ultrafast responses do follow the normativity imposed by the task, for example, of identifying whether there is a dog in an image; thus, they can hardly be seen as "raw processes" within a longer sense-making process.

Moreover, accepting this option implies that the basis of the meaningful agent-environment relationships in which ultrafast responses occur is not entirely in the here and now, such as in terms of ongoing evaluation and regulation, but would have been also constituted in the past. This would require giving up the axiom of structural determinism. If the meaningfulness of ultrafast responses derives from their belonging to a longer unfolding meaningful act, then the change of the state of the system in a given moment will be normatively determined by a contextual past condition.

Furthermore, it is not entirely clear how far in the past and even in the future a minimal act of sense-making should reach. In Sect. 4, we considered at least three layers of normativity that guide an ultrafast response, and which presumably make it meaningful: (1) the norms that guide the ultrafast performance itself, for example, responding to the presence of an image of a dog, (2) the norms established in the experimental setting by the instructions, and (3) the sociocultural factors that make taking part in an experiment a meaningful act. Notice that the first level of normativity

would be incomprehensible without the other two: releasing a key when there is a dog visible on a screen only makes sense when embedded in a larger sociocultural and normative context. Each of these levels of normativity correspond to different temporal scales of unfolding activity going from milliseconds at (1) to years of socialization in (3). If the normativity that guides an ultrafast response in a given moment comes from it belonging to longer acts of sense-making, it might be the case that such an act has started as early as the beginning of the learning or socialization process of the participant.

3. The third possibility is to explain the normativity of ultrafast performances as constituted only by the agent's history of past interactions.

This brings us to consider the approach preferred by radical enactivism (Hutto and Myin 2013, 2017). In their view, the normativity of skillful engagement with the world should be explained in terms of a history of selection, whether in evolutionary, ontogenetic, or learning time scales. Thus, the organism's current activity is imbued with normativity only with respect to what has worked in the past. And indeed, part of the dynamical account of strong anticipation involves appeal to a history of agent-environment coupling that has left the system poised in just the right kind of way to respond adaptively at very fast time scales. So, it may be just a small step to argue that this same history is also responsible for the fact that these responses are acts of sense-making, which, in Hutto and Myin's terms, would amount to an organism's intentional world-directedness with phenomenal properties. Like the second possibility, this also requires giving up the axiom of structural determinism.

However, Hutto and Myin's proposal that the normativity of current acts is only constituted by the past, namely by the fact that similar acts in the past worked or did not work, has strange implications. First, there is a problem of novelty: a purely past-based normativity would leave unexplained agents' normative sensitivity to the specificities of a current situation, that is, their ability to produce ultrafast responses to perturbations that have never been encountered before, such as having your jaw pulled while pronouncing syllables. Second, this account presupposes what it attempts to explain: Assuming that new instances call for a normatively guided behavior because they are sufficiently similar to other instances in the past leaves unexplained why, in the first place, the agent is able to recognize the relevant similarities in the new situation, which is itself a normative act. In both cases the current circumstances and specific triggers of a behavior would themselves play no constitutive role in determining its success or failure because the normative criteria would be purely historical. This suggests that we should not give up on the constitutive role of the present moment altogether.

4. The fourth possibility is to explain the normativity of ultrafast performances as constituted by both past and present agent-environment interactions.

Giving up the axiom of structural determinism allows us to define ultrafast cognition more holistically and relationally, since there is no reason now for the enactive approach to avoid appealing to the historical context of the agent. Monitoring and regulation are achieved operationally by virtue of being in a critical, anticipatory state. Yet their normative character is not derived exclusively from the current state of the

system, but also from the whole unfolding interaction. In other words, a mechanism for monitoring and evaluation would be an ongoing process but one that also reaches back in time. In fact, we suggest reconceiving the radical enactivist appeal to the constitutive role of past selection as referring precisely to such longer timescale processes.

Normativity would therefore arise with respect both to successful behaviors in the past and to the particularities and triggers of a current situation, and both past and present sources of normativity would be condensed in the transition from a strong anticipatory state to an overt ongoing interaction. The history of past selection shapes the possible responses of the agent and their normative constraints, while the peculiarities of the current situation would allow the agent to perform the right response and, when it is not possible, to learn novel responses. If so, then radical enactivism would have to include the specificities of the present moment as another constitutive element in addition to past history, which would permit it to avoid the problem of presupposing the normativity involved in selecting the right past response in the present moment.

Similar conceptions of cognitive processes have been proposed recently. For example, Jurgens and Kirchhoff (2019) argue that processes at play in social cognition are diachronically constituted by microscale and macroscale processes that stand in a relation of circular causation. So, it seems reasonable to adopt as a working hypothesis that sense-making is constituted by both past and present agent-environment interactions, and that normative constraints could come from the past.

6 Conclusions and future work

We showed that ultrafast cognition opens a clarificatory challenge for the enactive approach with respect to how to operationalize monitoring and regulation, and with respect to the temporal scale of sense-making. Ultrafast cognitive performances are forms of sense-making that occur too fast for long-range feedback to take place. The preferred enactive explanation of these performances relies on the constitutive and normative role of their historical context. However, this explanation is in tension with the axiom of structural determinism which captures the original enactive conception of history as only playing a causal role, not a constitutive one. We argued that if this axiom holds true, it is not clear how ultrafast performances can be adaptive. We considered three solutions and proposed a fourth one that rejects the axiom of structural determinism, recognizes that both past and present play a constitutive role in sense-making, and shows a convergence of enactivism and its radical counterpart.

There are further open questions regarding this conciliatory possibility. First, it is unclear how much constitutive weight radical enactivism would be willing to assign to interactive processes unfolding in the present in order to ground the normativity inherent in intentional directedness and phenomenality. And second, it remains to be seen how far back in time it is acceptable for the enactive approach to extend the basis of the normativity of sense-making. For it is one thing to conceive of the constitutive basis of normativity of an act of sense-making as being temporally extensive across an agent's lifetime, but it is a different matter to conceive of it as extended over generations, perhaps even over evolutionary timescales. However, the minimal physical and physiological basis of events necessary for a sense-making act that is based on eval-

uation in a wider temporal scale should be clarified. This kind of spooky entailment of normativity over temporal distance may be something to be considered seriously, especially since it was not too long ago when the claim that mind is spatially extended was met with equal disbelief. That kind of spatiotemporal extensiveness would be a radical life-mind continuity indeed.

Accepting a diachronically constituted mind also has philosophical consequences worth developing further. For example, if our past is constitutive of our present experience, then there is no ground for putting forward the skeptical argument that the universe could have popped into existence fully formed a second ago, and that this would make no difference to our current experience of the world. Counterfactually, it would indeed make a difference if there was a past or not, because, according to our preferred account, the past is part of what constitutes the normative dimension of sense-making in the present. The diachronically constituted mind would also have consequences to the enactive conception of human sense-making. As human interactions are crucially with and through others, especially during the first years of life, it could be argued that past social interactions not only shaped cognitive processes then, but that they also have a normative weight in our sense-making acts through life. Thus, past social and interactional normativities would be at work even in our current solitary sense-making acts. This would bring human sense-making closer to philosophical accounts of meaning, such as Wittgenstein's, in which social practices are the core foundation of meaning normativity, and it would clarify why and how most of our human skills are socially constituted.

Acknowledgements Laura Mojica acknowledges support by a scholarship granted by the Mexican Council for Science and Technology (Consejo Nacional de Ciencia y Tecnología, CONACyT). Both authors thank the 4E Cognition Group for all the helpful discussions. We thank our anonymous reviewers for patiently helping us to improve this paper.

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