Do babies represent?
On a failed argument for representationalism

Published at *Synthese*. Please quote the published version at:
https://doi.org/10.1007/s11229-022-03728-5

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Abstract: In order to meet the explanatory challenge levelled against non-representationalist views on cognition, radical enactivists claim that cognition about potentially absent targets (i.e., higher cognition) involves the socioculturally scaffolded capacity to manipulate public symbols. At a developmental scale, this suggests that higher cognition gradually emerges as humans begin to master language use, which takes place around the third year of life. If, however, it is possible to show that pre-linguistic infants represent their surroundings, then the radical enactivists' explanation for the emergence of higher cognition is defeated. In this paper, I critically assess experiments designed to show that pre-linguistic infants inherit (or develop very early on) representational abilities. I begin by outlining these experiments in section 2. In section 3, I argue that these experiments only succeed in supporting widespread representationalism by committing a particular kind of circular reasoning, which I call *conjunctivist reasoning* due to its origins in the debates about the nature of perception. I conclude by developing two independent yet congruent enactivist lines of interpretation for the experiments discussed in 2. I explain the infants' responses to atypical experimental conditions based on agent-environment codetermination (section 4) and then I argue that surprise behavior can be explained in terms of embodied habits and unfulfilled anticipation (section 5).

Keywords: radical enactivism; pre-linguistic infants; mental representations; conjunctivism; organism-environment codetermination; enactive anticipation

1. Introduction

Representationalism is generally thought of as the demarcation or conceptual thesis that representational content is the mark of cognition. It came under attack by the embodied and enactive turn in the cognitive sciences, which was initially set in motion by Gibson's (1966b, 1979/2015) ecological psychology and received its name after Varela et al.'s (1991/2016) embodied mind hypothesis. Among the embodied theorists, enactivists maintain that cognition emerges through autonomous sensorimotor engagements that do not require representational content. As the roboticist Rodney Brooks puts it, 'when we examine very simple level intelligence we find that explicit representations and models of the world simply get in the way. It turns out to be better to use the world as its own model' (Brooks, 1991, p. 140). More simply put: organisms directly interacting with the world do not need to represent it internally.

Recently, the radically enactive approach to cognition advanced by Dan Hutto and Erik Myin (2013, 2017) provided a more incisive argument against representationalism, namely, the Hard Problem of Content. According to radical enactivism (henceforth, REC), representational content cannot be naturalized because it is supposed to convey semantic information within the cognitive system. That is (according to representationalists), representations carry information *about* the distal source of stimuli through physical vehicles, such as brain areas activating in tandem. The kind of information we find in nature, however, is not semantically laden, but covariational. States that merely covary, such as rings in the trunk of a tree and its age, or patterns of neuronal activation and specific cognitive tasks, carry no semantic information. Which is to say that covariation does not imply content. Hence the Hard Problem of Content: either proponents of mental representation agree that not all cognition is representational or hold on to the promise of delivering an explanation of how we could derive semantic information from covariational states. Given that the latter option hasn't been properly carried out, and given philosophical naturalism, the only available option is the first prong of the dilemma. This is all REC needs in order to contest representationalism.

However, it stands to reason that we (and perhaps some other animals) are capable to engage with potentially absent targets, that is, targets that we cannot directly explore via sensorimotor engagements. Prime examples are planning, remembering and inferring. These cognitive capacities are known as *representationally hungry tasks* (Clark & Toribio, 1994), and they remain a challenge for enactivism and similar views. Although the verdict is not yet out on the scope of the class of representationally hungry tasks (Bruineberg et al., 2019; Kiverstein & Rietveld, 2018, 2021; Rietveld & Kiverstein, 2014), plausibly *some* cognition is representational, the so-called 'higher' cognition—as opposed to online cognition about the immediate environment, or 'basic' cognition.[1]

REC's way of meeting that explanatory challenge is to argue that basic cognition enables higher cognition as the individual becomes enculturated, that is, as they partake in sociocultural practices (Hutto & Myin, 2017). These practices first took place with flint knapping and were greatly expanded in Upper Paleolithic, thereby giving rise to behavioral modernity (Menary, 2015). From that period onwards, concrete symbol manipulation, such as use of clay tokens, became increasingly complex (see also Malafouris, 2013). Engaging with publicly shared symbols eventually allowed for written language and symbolical numerical counting, which became progressively more intricated due to feedback loops. So, as public symbols became more widely used, we incorporated them into our shared cognitive repertoire, plausibly through the exaptation of more ancient cognitive abilities and their neural correlates. The abilities to think about the future and to recall about the past, for instance, are the outcome of a long evolutionary process of engaging with symbols which are distributed in sociocultural settings. Although we could regard public symbol as 'representations', they are not *mental* representation in the classic sense. If successful, therefore, this strategy eases the need to postulate mental representations in order to explain higher cognition, for the latter evolved from more basic engagements. In this paper, I endorse REC's attempt at

[1] However, not all enactivists endorse the distinction between different levels of cognition (e.g. De Jaegher, 2019). If one adheres to a strict continuity between life and mind—as some enactivists do (Di Paolo et al., 2018; Thompson, 2007)—then the same kind of processes that give rise to life also give rise to cognition. Accordingly, a higher-order level of cognition, which is not found in other living beings, may be the wrong way to frame the enactivist approach. REC, however, rejects a strict continuity between life and mind as an ontological thesis. The ontological reading present in some enactivists' work is due to the influence of Jonasian phenomenology (see De Jesus, 2016, for a discussion).

explaining higher cognition, but it should be noted that it can be approximated with other recent enactivist developments (see Rolla & Huffermann, 2021 for a discussion).

Thus, REC's strategy is to scale up basic cognition through sociocultural scaffolding, which happens over an evolutionary time scale. Crucial to this process is the idea that publicly shared symbols such as those present in written language became internalized by modern humans. At a developmental or ontogenetical scale (i.e., the timeframe of an individual's life), REC's explanation suggests that higher cognition gradually takes place as we begin to master language use, which normally happens around our third year of life (Hoff, 2014). If, however, it is possible to show that pre-linguistic infants represent their surroundings, then REC's explanation for the emergence of higher cognition is defeated. In this paper, I will examine arguments based on behavioral analyses of infants that supposedly provide evidence for representational states before the development of linguistic capacities. By doing so, I will not engage in the ongoing debate about whether neurophysiological bases can meet the "job description challenge" for there being representational content (Ramsey, 2007; see also Facchin, 2021; Poldrack, 2021). My intent is to evade that discussion and focus on another front in order to provide a different outlook on the so-called "representation wars" (Constant et al., 2021; Williams, 2018).

I begin by outlining experiments designed to show that pre-linguistic toddlers inherit (or develop very early on) representational abilities (section 2). An important aspect of these experiments, as I will highlight below, is the atypical experimental conditions used to infer representational states in the subjects. In section 3, I argue that these experiments only succeed in supporting widespread representationalism by committing a particular kind of circular reasoning, which I call *conjunctivist reasoning* (CR) due to its origins in the debates about the nature of perception. After mapping ways of responding to that challenge based on its construal as an instance of CR, I present two independent yet congruent lines of response available for enactivists, one based on agent-environment codetermination (section 4) and another based on a non-representational account of surprise and expectation (section 5).

2. The case for representational states in pre-linguistic infants

It is one thing to say that neurotypical human adults can entertain cognitive states about absent targets. As we have seen, REC accommodates that commonplace phenomenon quite naturally by explaining that we become socioculturally scaffolded through the engagement with publicly shared symbols. This developmental process allows us to perform sophisticated cognitive acts that do not involve the immediate environment. It is another thing to show that *pre-linguistic infants* have representational states. For, if it is possible to show that representations show up significantly before language mastery, then REC's explanation for the emergence of higher cognition is threatened. In this section, I present some studies that supposedly show just that. It is important to go into some details of those experiments because one of their most crucial features is the abnormality of the conditions used to indicate representational states in pre-linguistic infants. This, I suggest, is one of the weaknesses of the argument for representationalism afforded by these studies, a weakness that REC (and other varieties of enactivism and embodied cognition) should explore in response to it.

In the early 90's, a series of now classical experiments were conducted to show that infants of only 3,5 months old already display notions of object permanence, which is much earlier than Piaget's (1954) previous estimation for the emergence of that capacity. Whereas Piaget's experiments relied on manual search tasks—where babies would reach for objects—studies on child development conducted from the early 80's onward used novel visual tasks and eye monitoring devices (see Baillargeon & DeVos, 1991 for a brief review of early experiments), which in turn allowed for more precise results.

In one of Baillargeon and DeVos's (1991) experiments, infants of around 3,5 months of age went through an habituation phase with the experiment, after which they were shown two tests events, a possible and an impossible one, and their gaze in each case was measured. In the habituation phase, observers would face a scene were a toy carrot slides on a track across a platform from left to right, passing through a screen that occludes the center of the track. On alternate trials, toys of different size were used, a short and a tall carrot, in order to further habituate the child with the scene. In the test events, a large window is cut from the midsection of the screen's upper half. In the possible event, the

shorter toy carrot slides through the screen, but because it is smaller than the window's lower edge, it does not appear through the window as it goes behind the screen before showing up on the other side. In the impossible event, the tall carrot passes behind the screen. Given its size, however, it's top half should show up through the window, but it is ingeniously hidden from view, and an identical carrot is shown on the other (right) side of the screen. Baillargeon and DeVos registered an increased mean looking time in the impossible event, indicating surprise by the infants thus, according to the authors, an expectation (representation) of object permanence. No significant difference in mean looking time was noted in 3-months-old, which they admit is open to several different interpretations (Baillargeon & DeVos, 1991, p. 1236).

Another experiment discussed in the same paper consisted in showing 3,5-months-olds a toy car going down a ramp from left to right. In the center of the scene, there is a screen occluding part of the car's trajectory. In the habituation phase, the screen is lifted in order to show the continuity of the tracks, then lowered before the toy car goes through. In the impossible test event, as the screen is lifted, another toy is revealed to be exactly on the car's track, thus blocking its way. The screen is then lowered, and the car goes down the ramp. At this moment, the toy is surreptitiously removed before the car goes through. In the possible test event, as the screen is lifted, the toy is noticeably a few centimeters behind the track, allowing the car to pass through when the screen is lowered. Interestingly, increased mean looking time in the impossible event was only noticed in female participants, and a further experiment confirmed that this reliably happens only after 4 months of age.

Prior to those experiments, Kellman and Spelke (1983) had developed a series of experiments in order to test the perception of partly occluded three-dimensional objects in 4-months-old. The authors describe and discuss six experiments, where in a series of trials infants were habituated to an object (such as a rod or a polyhedron) whose center was partially occluded by a block. Afterwards, subjects were shown two tests displays where the occluding block had been removed. In one of them, the object was undivided, as one would expect (normal or typical scenario). In the other type of test, the object was segmented in the middle where the occluding block had been. This is an atypical case,

especially in those trials where the two parts of the occluded object had been moved in synchronicity, as if they formed a single piece. As in the other experiments mentioned above, the infants looked reliably longer at the object in atypical cases, i.e., when the object was segmented at the middle. The longer look is a mark of preference for a given scene, suggesting that segmented objects were novel, contrary to the infants expectations, thereby indicating that 'the ability to perceive objects may emerge in infancy, without learning, by virtue of an inherent general conception of the physical world' (Kellman & Spelke, 1983, p. 486).

Similarly, a couple of experiments by Baillargeon et al. (1992) show that infants from 5,5 to 6,5 months old look reliably longer at atypical events regarding support and partial support. In a habituation phase, the infants observed a scene where a box is dragged by an experimenter from left to right over two adjacent platforms. In one condition, after being dragged, the box stood mostly on the rightmost platform (only 15% of its bottom surface was over the leftmost platform). In another condition, about 70% of its bottom surface remained over the leftmost platform after being dragged. In the test events the rightmost platform was removed, and the box was dragged to the right in the same manner as in the habituation phase. In the atypical partial-contact event, the box was dragged across the platform until only 15% of its bottom surface remained supported by the platform. Given that it's center of mass was off the platform, it is predicted to fall—but a well-hidden rod behind the box (invisible to the infants) was actually responsible for keeping the box stable. In another partial-contact event, the box was again dragged towards the edge of the platform, but retained 70% of its bottom surface over the platform, thus being properly supported (typical event). As in the other cases, the infants looked reliably longer at the scene when observing atypical events, thereby suggesting that 'beginning around 6,5 months of age, infants expect an object to remain stable if a significant portion of its bottom surface is in contact with a supporting platform' (Baillargeon et al., 1992, p. 76).

So, what do these experiments (and other similarly designed ones) show? It seems unquestionable that they reliably indicate the earliest manifestations of surprise behavior regarding atypical observational circumstances. Whether this implies the more

contentious view that we have innate representational abilities is another matter. Curiously, however, some have taken these experiments to imply just that. Notice for instance how the leading neuroscientist Stanislas Dehaene (2020) frames their philosophical consequences. He claims the 'nascent brain already possesses considerable *knowledge* inherited from its long evolutionary history'. He also says that babies have 'deep *intuitions* of the physical world' (p. 54, my emphasis), that they have an '*understanding* of mathematics' (p. 56, my emphasis), that they are 'genuinely *sensitive* to the number itself' and that they '*build an internal model* of the hidden scene and *know how* to manipulate it by adding and removing objects' (p. 57, my emphases). He also talks about 'innate skills' (pp. 57, 58), 'innate abilities' (p. 53, 65), 'attunement', 'core knowledge' and 'invisible knowledge' (p. 58).

Those are all epistemic phrases, but some are obviously weightier than others. It seems particularly contentious to say that babies (of only a couple of months of age) have *propositional knowledge* or *understanding* about a given matter, because both knowing-that and understanding-of require not only representational states, but also conceptual content, thereby demanding a more acute language mastery than what babies plausibly have. On the other hand, Dehaene talks about know-how, attunement, skills and abilities, which is a more sympathetic way of speaking considering the enactivist epistemology (Myin & van den Herik, 2020; Rolla & Huffermann, 2021). Between these two extremes, one also finds some expressions of representationalism that do not go as far as to imply propositional content. One such case would be the idea that babies would have "internal models" of certain matters. To a traditional cognitive scientist (that is, one committed to representationalism, but not to pervasive conceptualism), this would seem to be the most precise and less onerous way to articulate the cognitive processes highlighted by the experiments. The overall idea would be that babies either inherit or develop very early on in their life the mental representations of how things should be, for deviations to that norm cause a behavior of surprise, as measured in the duration of their gaze. In the next section, I provide a critical assessment of this reading.

3. The flaws of conjunctivist reasoning

So, do those experiments succeed in showing that pre-linguistic infants have representational states? I believe not, because the argument from the observed phenomena—namely, the behavioral response from babies when faced with atypical events in comparison to typical ones—to the postulation of representational states is prone to what I call *conjunctivist reasoning* (CR). CR is a class of arguments that hinges upon the idea that *typical and atypical conditions for an exercise of a given capacity (e.g., perception) or for experimental settings (e.g., gaze duration in babies) are fundamentally the same*. Perhaps the most famous case of CR, from which it earns its name, is the argument of hallucination (or illusion),[2] which is advanced in favor of sense data theories of perception. That argument intends to show that perceptual states are mediated by sense data, which are common to both actual perception and atypical (non-perceptual) states, such as hallucination and illusion—and perhaps dreams and delusional states as well. The reason for this is that hallucinating individuals appear to perceive things as so-and-so, just like in genuine perceptual cases. More schematically, the argument goes as follows:

1. In cases of genuine perception, the subject's (S) perception is a state with a given quality (Q) caused by a distal source in the actual environment.
2. In an atypical state (illusion or hallucination), S appears to have an experience with the same quality Q as in genuine perception—i.e., atypical and genuine perceptual states are qualitatively indistinguishable.
3. Given that, in an atypical state, S lacks contact with the distal source that normally causes Q, there is something responsible for Q other than the actual environment. Call it *sense data*.

[2] The parenthesis goes with a caveat. As Favela and Chemero (2016) point out in their discussion about the nature of illusion for ecological psychology, one should be wary of bundling illusion and hallucination together simply because they are, in a way, non-perceptual states. Their reasoning is that illusions are stable and replicable, whereas hallucinations are idiosyncratic and potentially irreproducible across different subjects. Accordingly, they define illusions as attempts to perceive in environmentally atypical conditions (such as observing figures that cannot be manipulated or interacted with in experimental settings), whereas hallucinations may be caused by a host of biopsychological factors. The same seems to hold unproblematically for an enactivist approach to illusion. But I put together illusion and hallucination in this instance of CR well aware of Favela and Chemero warnings (and in agreement with their considerations). I only do so because that is the way that argument is typically presented, that is, without the subtlety of distinguishing those two non-perceptual states.

4. If, in atypical states, Q is caused by sense data, then sense data are also present in cases of genuine perception by S that display Q.
5. Therefore, sense data are also present in cases of genuine perception by S that display Q.

As Austin (1962) famously shown, the argument above is logically flawed because it commits a specific kind of circular reasoning—and, although circularity can be avoided, doing so comes with the price of its validity, thereby rendering the argument useless. More precisely, the point is that 1-5 only succeeds under the assumption that whatever explains the quality Q in atypical states (sense data) also explains Q in cases of genuine perception—that is, that perception and hallucination (or illusion) have the same epistemic profile. But this is to suppose precisely what the argument purports to prove, namely: that every perceptual experience, be it typical or not, is mediated by sense data. If we do not accept beforehand that critical assumption underlying premise 4, the conclusion at 5 is unwarranted. In other words: it does not follow from the fact that some experiences are mediated by sense data that all experience is—unless we already assume it is. It might as well be the case that perception and hallucination (or illusion) are experiences of epistemically different kinds, as disjunctivists hold (Hinton, 1967; Neta, 2008; Pritchard, 2012). Moreover, as Austin goes on to argue, in the context of the similarly structured dream argument, it is doubtful whether waking and dreaming experiences can have exactly the same phenomenal quality, otherwise the "dream-like character" which is sometimes attributed to some experiences, would be trivially true for any experience whatsoever (Austin, 1962, pp. 48–49).

Now, back to our main argument for representational states in pre-linguistic infants. I believe those arguments commit to a similar pattern of reasoning, which can be construed as an instantiation of CR [3] —at least insofar as they are used to confirm

[3] Another empirical instance of CR was denounced by Richard Lewontin (2000) in his discussion of how geneticists have attempted to show that there is an exclusive causal chain from genes to traits. In studies about genetic mutations with fruit flies, it is possible to observe the effects of drastic interventions on the development of an organism, confirming the variation with which interventions generate significant morphological anomalies (see Mark et al., 1997 for an overview). Lewontin correctly points out that these experiments only show that a *drastic intervention causes a developmental anomaly*. However, it does not follow that typical phenotypes are exclusively determined by the genotype. In fact, the experiments in

representationalism (understood as a conceptual thesis). As we will see, this is the crux of the matter, because representationalism cannot be empirically confirmed by experiments that measure visual surprise, even though they have been taken to do just that (Dehaene, 2020). But first, in order to see how the experiments discussed above instantiate CR, note that the claim that *pre-linguistic infants represent how things are supposed to be* is an inference to the best explanation from the fact that they reliably look for longer time when observing atypical experimental events. But is that inference authorized? It depends on the following assumptions: first, that increased looking time is a measure of surprise. Secondly, that surprise is an indication of representing how things should be. That is, surprise supposedly implies not only a sensitivity to cases that deviate from the norm, but also an awareness that these cases are in fact atypical, i.e., that things are not as they should be. If those assumptions are in place, it follows that 3,5-months-olds (e.g.) already represent how things should be. Moreover, whether such expectations are innate or quickly acquired in that short life span is irrelevant to disprove REC's claim that higher cognition shows up much later in virtue of language development. In order to highlight the flaws of that kind of argument, we can interpret it along the same lines of the argument 1-5 above, thus providing another instance of CR:

6. When observing typical events, any given pre-linguistic baby (B) stares at those events for a mean duration of *t*.
7. When observing atypical events, B stares at those events for a mean duration that is reliably longer than *t*.
8. Given that, in atypical events, B stares at those events for longer than *t*, B is surprised. Hence, B represents how things should be.
9. If B represents how things should be when observing atypical events, then B also has representational states when observing typical events.
10. Therefore, B also has representational states when observing typical events.

question only support a linear causal chain from gene to phenotype under the assumption that the organism is not a complex system (see Lewontin, 2000, p. 96). That is, if biological systems observe a regime of causal linearity, it follows that an anomaly caused by a drastic intervention confirms that the typical phenotype is caused exclusively by the genes. But this is just to suppose a causal linearity from gene to phenotype, that is, to suppose exactly what the argument is intended to prove.

Notice that 6 and 7 are factual premises—or at least, the theoretical constructs they involve (*typicality*, *mean duration*, *longer time*, etc.) are not obviously under dispute. So, our focus shall be on the premises 8 and 9. Analogously to the argument from 1-5 above, the circular reasoning is now due to the fact that, if mental representations of physical events enter the play in atypical cases, it only follows that mental representations are also present in typical conditions under the assumption that the cognitive procedures are the same in both kinds of cases. This is the motivation for premise 9, which is therefore a form of conjunctivism (experimental rather than conceptual in this case). Typical and atypical engagements with one's environment are assumed to share the same representational profile. But to assume so is to assume that representational content is the mark of the mental. Therefore, to the extent that the argument from 6-10 already takes representationalism to be true, it does not offer independent support for it.[4] Thus, the question-begging move that motivates premise 9 is the reason why the kind of experiments discussed above fails to show that we inherit or develop representational states long before language mastery.[5]

So, at this juncture enactivists should follow the disjunctivist playbook and argue that different environmental conditions invite different kinds of interaction, i.e., different sensorimotor coordination patterns. In fact, this is perfectly in tune with the situated

[4] Interestingly, Austin (1962, p. 47) noted a similar problem for sense data theorists in his comparison of how A. J. Ayer and H. H. Price advance the argument from hallucination. According to Austin, Price takes the question of whether we are always aware of sense data to be settled, his aim therefore being only to prove that sense data are parts of the surfaces of material objects. No circularity here. Ayer, on the other hand, intends that argument to be a proof of indirect perception (hence displaying the first instance of CR discussed above). The analogy here is that sense data theories cannot be proven non-circularly, just like representationalism possibly cannot be empirically supported without circularity, at least based on the experiments discussed in section 2.

[5] It is an open question whether other empirical arguments that could (in principle, at least) be presented as independent support for representationalism would exhibit the same circular pattern. Recently, Ramsey (2017) has argued that cognitive scientists must choose between representationalism as a demarcation thesis or as an empirical one. He points out that a demarcation or conceptual view hinders scientific progress, for representational posits cannot figure *both* as criteria for cognition and as falsifiable (empirical) theoretical constructs. So, when it comes to which view one should adopt, Ramsey defends giving up on the demarcation thesis in favor of an empirical approach. But if the issues highlighted here can be generalized to other kinds of empirical arguments in favor of representationalism, it would follow, contra Ramsey, that representationalism is better thought of as a conceptual framework, one that has been thoroughly challenged by enactivism and like-minded views, rather than being open to empirical confirmation. But notice that, even if that is the case, I am not arguing for the more general view that *no conceptual (or philosophical) thesis can be empirically confirmed*.

aspect of enactive cognition, for cognition spans one's dynamic engagement with an environment. Accordingly, in those cases where there is a radical departure from typical scenarios, such as when a box starts to "float" after being dragged across a platform, the observer is in a substantially different environment, which therefore calls for other cognitive performances. Infants might, for instance, compensate with another cognitive act, such as searching for an extra support hidden somewhere. This may be one way to explain the longer stare at this kind of (atypical) experimental event. If that is the case, the cognitive procedures in atypical and typical cases might not be the same, and conclusions drawn about the former do not automatically apply to the latter. If that is the case, it does not follow that the infant's access to their environment in normal circumstances is thoroughly representational.[6]

Enactivists are also entitled to reject another assumption crucial for the argument above, namely, that surprise is an indication of representing how things should be (which underpins premise 8). This move is important because, even if the cognitive acts are different in each case (by rejecting 9), atypical circumstances are such that they trigger surprise—and, so the argument goes, surprise indicates representation. In other words, merely denying that babies entertain representational states in typical cases is not a good standing for REC. For it would remain true that babies are representing when engaging with atypical physical events (premise 8 above). Mental representations, even if rare, would still appear long before more well-refined language development, thus undermining REC's explanation of higher cognition. That is why an adequate response to that challenge must involve a further step, which is to provide an alternative explanation

[6] I'm not suggesting enactivists *should* be disjunctivists (or vice-versa), but it is indeed an interesting combination, for enactivism would be able to provide a unified explanation for two main claims of disjunctivism. Namely: (a) that genuine perceptual experiences do not have the same phenomenal character as atypical ones and (b) that genuine perceptual experiences do not have the same epistemic profile as atypical ones. In support for disjunctivism, enactivists can explain the phenomenal character and the epistemic profile of genuine perceptual experiences as the outcome of autonomous sensorimotor engagements in appropriate environmental settings. Atypical experiences occur when sensorimotor engagements are either incomplete (i.e., lacking environmental feedback or afferent signals), or are exercised in evolutionarily atypical conditions that do not afford engagement. Those experiences would be cases of hallucination and illusion, respectively. But for this match to work, disjunctivists have to give up on the claim that genuine perception is *factive*, for factivity implies propositional content. Propositional content, in turn, implies representational content, which is precisely the point of contention raised by enactivist. The way out of this would be to think of perception as a *successful* world-engaging epistemic state, rather than using the stricter notion of *factivity* (see Rolla & Huffermann, 2021, for this suggestion).

for the longer stare in atypical conditions without a commitment to representational content. In the next two sections, I develop two independent but congruent lines of response that allow RECers (and enactivists more generally) to reject premise 8 of the argument from 6-10 above.

4. Organism-environment codetermination

This first line of response available for enactivists considers the evolutionary timescale. In order to see that, we should recall an important lesson from *The Embodied Mind* (Varela et al., 2016), one which is not always fully appreciated in recent enactivist literature. As it is well known, Varela and colleagues make an important case for the *codetermination of organism and environment*, which means—at least at a first approximation—that cognition is not the passive apprehension of a pregiven world. Passively receiving or accessing a pregiven world is the mark of a naïve realist view (see De Jesus, 2018), a view that Varela et al. reject because it would obviate the autonomy of cognition and life. Accordingly, organisms autonomously select the environmental features which are relevant for their self-maintenance, and they do so under the constraints of their bodily morphology and acquired dispositions. Thus, through the autonomous coordination of its sensorimotor abilities in its environment, the organism *brings forth its world*.

However, if we neglect how the environment contributes to that process, we might be led to think of enactivism as what Rolla and Figueiredo (2021) call a "revamped version of idealism", for the organism would project its own cognitive makeup onto a world. We see this criticism echoed for instance in Heft (2020) and Villalobos and Dewhurst (2017) (see also Vörös et al., 2016, for a discussion). If that were the case, the roles ideas play in traditional idealism—i.e., that of mediating mind-world relations and providing the ultimate matter and form of cognition—would be played by sensorimotor structures. Note, however, that Varela et al. (1991/2016, chapter 8) explicitly attempt to avoid both naïve realism *and* idealism in their embodied and enactive approach to cognitive sciences. So, in order to reject that idealist construal of enactivism, it is crucial to understand how the environment contributes for cognition.

In that regard, the overall idea is that cognitive structures are not pregiven (as an idealist might assume) but determined by environmental ones over large time scales. This naturally leads to considerations about evolution. For this, Varela and colleagues explain (1991/2016, chapter 9) how the enactive approach represents a radical departure from adaptationism, which is the received view on evolutionary biology (and was even more so in the early 90's). According to adaptationism, the morphological features of an organism are the outcome of its adaptation to external pressures, a view that is combined with Mendelian genetics to form what is known as modern evolutionary synthesis. Varela et al. draw from considerations by Gould and Lewontin (1979) and Oyama (1985/2000) and argue that adaptationism is akin to cognitivism in a crucial sense, for both views take their respective explananda (evolution and cognition) as conforming to pregiven circumstances. Rejection of cognitivism therefore naturally suggests the rejection of adaptationism.

In an attempt to reconstrue Varela et al.'s positive views regarding evolutionary biology, Rolla and Figueiredo (2021) argue that the authors' recurring phrase 'to bring forth a world' must be construed literally. With the aid of recent developments from post-adaptationist views in evolutionary biology, mainly niche construction theory (Laland et al., 2000b, 2000a, 2016; Lewontin, 1983; Odling-Smee et al., 2003), Rolla and Figueiredo argue that the outcomes of organismic actions in an environment, when sufficiently stable, are preserved across generations. These outcomes thus become a non-genetic or environmental type of inheritance for the organism's descendants.[7] The environmental inheritance of an organism by the doings of its forebearers then shapes its present interactions and offers new evolutionary pathways. Accordingly, evolution is not entirely passive, or exclusively due to external selective pressures, for it is at least partially driven by the organism's doings.[8] Importantly, for niche construction theory, the way evolution

[7] Within ecological psychology, a similar view was developed by Heras-Escribano (2020). Heras-Escribano argues for a compatibility between ecological psychology and niche construction theory, thereby showing that affordances are both resources *and* ecological inheritances. This, I believe, is broadly convergent with the main argument of this section, but for simplicity as well as for brevity I will not compare our views here.
[8] Which obviously is not to say evolution is *teleologically* driven (in a strong sense), for living beings do not have the end-state of their evolutionary processes in sight when they strive for survival.

is driven by organismic doings is not random, for this would not be advantageous for survival. On the contrary, this process is coherent and integrated with the organism's phenotype and behavior, because:

> Organisms in the same species possess broadly similar evolved capabilities for niche construction, so they are expected to modify environmental states in broadly similar ways, while the niche construction by offspring is expected to resemble that by their parents [...] Even the niche construction that arises as byproducts of metabolism is likely to be consistent and orderly, since the biological processes from which they derive are reliably produced, generation after generation (Laland et al., 2019, p. 144).

Thus, *how* and *which* niches are built essentially depends on the organism's bodily morphology and its abilities, further approximating niche construction theory and the enactivist view on evolution. Regularity in niche construction by the members of a species explains, for instance, why modern humans build shelters that are similar, given very general parameters, regardless of cultural variation. Enculturation, in this sort of case, introduces new variables that modify the ways we construct our niches, and this generates differential effects in our evolutionary processes.

As an illustration, consider how the hominins lineage is marked by the behavioral plasticity to engage with radically changing environments, where some of those changes were caused by hominin activity itself. Sterelny (2012, chapter 1) notices that, by half-million years ago, our ancestors' hunting activities already left a significant ecological footprint, for their lifestyle directly and indirectly affected the absolute numbers, distribution, and behavior of other animals. At least two hundred thousand years ago, our forebearers became social foragers, thereby greatly increasing ecological changes and broadening their resources base. So much so that

> The populations of target species are depleted. Predators become increasingly rare, wary, or both. These environmental effects also create coevolutionary opportunities for species that will eventually domesticate, and for scavengers of various sizes (rats, mice, cockroaches, lice). We experience new pathogens as we change our mobility, residence patterns, and population size. Landscapes are altered (Sterelny, 2012, pp. 16–17).

Such drastic changes required the development of novel cognitive skills in order to deal with rapidly changing environments and potentially unforeseen circumstances. Accordingly, ways of channeling cross-generational information flow such as imitation and active learning became distinguishing features of early humans. This allowed for the invention of increasingly sophisticated forms of lithic technology, which in turn ensued the performance of more complex cognitive acts through material engagements (Malafouris, 2013), a dynamic that flourished incrementally with behavioral modernity. That is why we can talk about a *codetermination* between organism and environment, or the literal bringing forth of a world (Rolla & Figueiredo, 2021): our evolutionary background is a perfect example of how the organism's actions shape the environment, which over large time scales, affects its evolutionary pathways in feedback loops.

The foregoing allows us to explain, at an evolutionary scale, why infants look for longer when faced with experimentally atypical scenarios. First, it highlights that a baby's cognitive system is not a blank slate waiting for experiences to impinge it, but the outcome of a long process of organism-environment codetermination. This is in agreement with Dehaene's (2020) use of enactivist-friendly terms to express the relation of attunement between infants and their environments, which takes places due to their inherited embodied dispositions. Those dispositions are the general parameters for the development of abilities (or skills) whose successful exercises in appropriate conditions exhibit know-how.[9] Secondly, and most importantly, even if infants themselves have not shaped their own environment, or have done so only minimally, the environments they inherit were deeply manipulated by their ancestors. Due to common morphological features, humans intervene in their environments in broadly regular ways, so that the niches we build and inherit exhibit certain constancies. These constancies, over large

[9] Moreover, even though the process of historical codetermination goes way further than the emergence of the *Homo sapiens*, the most significant changes happened at the outset of behavioral modernity during the Upper Paleolithic. Then, our ways of interacting with our environments were deeply shaped by the introduction of symbol manipulation, and this has greatly affected our evolutionary pathways. That is why the label of 'pre-linguistic' might be misleading. Because babies are a product of long evolutionary processes that involve (and evolved) linguistic practices, newborns normally come equipped with the toolkit to develop the typical cognitive abilities of modern humans, which distinctively includes symbol manipulation. So, they are *pre*-linguistic in the sense that they usually go on—given appropriate environmental, cultural and biological conditions—to develop full-blown linguistic capacities. But this should not be taken to imply that they fundamentally lack something that appears latter on out of nowhere.

timescales, are codetermined with human cognition, not in the form of mental representations but in the form of our own embodied features and their evolutionary background. Accordingly, specific environmental events elicit specific cognitive responses, which become progressively more sophisticated as the infant grows, combines their skills, acquires new ones and actively participates on their sociocultural environments.

Therefore, atypical physical events as those designed in the experiments discussed in section 2 are not something we were evolved (and evolved ourselves) to respond to. In fact, those conditions are explicitly designed to be atypical, some even described as *impossible*, in comparison with those displayed during the habituation phases. My suggestion here is that our evolutionary background is codetermined with physically well-behaved environments, not the intentionally atypical ones designed by psychologists to test infants' surprise. Therefore, when faced with highly atypical testing scenarios, it is no surprise (no pun intended) that infants display an atypical behavior. This is due to their embodied attunement with environmental constancies, an attunement that is momentarily and radically disrupted by the abnormality of the observed events in test trials.

To frame the last point in REC's vocabulary of information as covariation (Hutto & Myin, 2013), we can say that, in normal circumstances the infant's embodied cognitive processes reliably covary with their environment—we should add, due to organism-environment codetermination. Atypical circumstances, on the other hand, breakdown this covariation. Plausibly, when such breakdowns occur, something else is required in order to reattain covariation—hence the longer look and whatever potentially novel cognitive acts it involves. But notice that, just like before, covariation (and its lack thereof) does not authorize an inference to representational states and the like.

5. Embodied habits and enactive anticipation

Having seen how we can defeat premise 8 in the argument from 6-10 based on considerations about enactive evolution (organism-environment codetermination), I hereby present a second line of response that focuses on the developmental timescale. I

draw from Esther Thelen and colleagues' (2001, see also Smith & Thelen, 2003) influential findings on the A-not-B error and combine that approach with the phenomenologically inspired enactivist account developed by Shaun Gallagher and collaborators in a number of places (Gallagher, 2017b; Gallagher & Rucińska, 2021; Gallagher & Zahavi, 2014, see also Gallagher, 2016, 2017a).

The A-not-B phenomenon is well known by developmental psychologists, again originally due to Piaget (1954). In his experiments, infants went through a habituation phase (similarly to the experiments discussed in 2) in which they observed the experimenter hiding a toy in a given location (A) for several trials. During A-location trials, subjects repeatedly reached for A. In test trials, children observed the experimenter hiding the toy in a different location (B). Piaget noticed that infants of 8- to 10-month-old exhibit a tendency to reach out for (A) during test trials, thus committing the A-not-B error. From this Piaget inferred that they lack the notion of object permanence. Object permanence would only show up around 12 months of age, which is when infants reliably locate the object in B-location trials.

Thelen et al. (2001) famously contested those findings on the basis of a dynamic systems approach. They designed a dynamic model with a one-dimensional activation field with parameters for the two locations (A and B), where points within the field serve as input to one another, so that 'a highly activated point [e.g., reaching for A in A-location trials] will exert a strong inhibitory influence over the points around it [e.g., reaching for B in test trials] allowing an activation to be maintained in the absence of external input' (Smith & Thelen, 2003, p. 345). Accordingly, the sedimentation of the sensorimotor loop of reaching for A is reinforced before test trials to the point of becoming a self-sustaining feature of the system. More simply put, reaching for A becomes a habit (Di Paolo et al., 2017). Due to its self-sustainment, the habit of reaching for A arises even in test trials (when the toy is in B), as long as there is a decay in the cue provided by hiding the toy is in that location. That is, if a certain amount of time has passed between the cue (hiding the toy) and the moment the child is allowed to reach for it, the error occurs. What Thelen and colleagues found out is that diminishing the delay between cue and reaching breaks down the habit of reaching for A, even for 8-month-olds. Experiments show that multiple

variables were found to be causally relevant for the breakdown (or maintenance) of the A-reaching habit. That is attested, for instance, 'by heightening the attention-grabbing properties of the covers or the hiding event […], by increasing and decreasing the number of prior reaches to A […] by shifting the posture of the infant [and] by putting on and taking off wrist weights' (Smith & Thelen, 2003, pp. 345–346).

The upshot of Thelen and colleagues' studies is that the notion of object permanence is not needed to explain the occurrence and the sudden disappearance of the A-not-B error. Instead, the explanatory work is done by considering how the development of embodied habits through multiple timescales shapes one's future actions, and how those habits can be undercut by many different causes. Crucial for our purposes is the fact that this general idea about the development of embodied habits can be cast in phenomenological terms, providing a more complete picture of surprise on a developmental timescale that does not imply representational states.

Gallagher's approach to Husserlian phenomenology is a step in that direction (2017b, see also Gallagher & Zahavi, 2014; Gallagher & Rucińska, 2021), for his account allows us to construe surprise as the unfulfillment of perceptual anticipation which is, we may add, constrained and enabled by one's embodied habits. Husserl's fundamental idea—as endorsed by Gallagher—is that time experience is a temporal field, not a series of successive snapshots of static states of affairs (Husserl, 1991). In experiencing an object unfolding in time, one's experience is constituted by three indissociable elements: *primal impression*, in which consciousness is 'narrowly directed toward the now-phase of the object'; *retention*, which refers to the 'just-elapsed phase of the object'; and *protention*, which is 'the component that, in a more-or-less indefinite way, anticipates the phase of the object just about to occur' (Gallagher, 2017b, p. 92). With these elements in mind, we can construe our current experience of a given object as constrained and enabled by past experiences as well as providing partial specification of future experiences. When listening to a melody, as in Husserl's famous example, which is also examined by Gallagher, our experience of a given note (primal impression) is informed by the previous ones (retention) and oriented by anticipation for future ones (protention). That is

partially why an out of tune or wrong note subverts the listeners' expectations—a trick that is used with success, for instance, by jazz musicians.

As Kiverstein correctly points out (2017), a natural expansion of Gallagher's phenomenological discussion is that not only consciousness has a temporal structure, but also that cognition in general is likewise diachronically structured. So, at the level of basic cognition, perceiving and acting are already guided by retention of previous experiences and, in cases of successful engagement, by fulfilment of protention. In other words, one's anticipation of near-future perceptual events is based on previous and current perceptual engagements, and if one correctly exercises one's sensorimotor abilities in the appropriate environments, one's anticipation is met. This is the fundamental reasoning for the idea that perceiving is the *readiness to act* in one's environment.[10]

In fact, such idea is implicit in Gallagher's account, for he writes that 'my primal impression of the present is already involved in an *enactive anticipation* of how my experience of the stimulus will unfold' (2017b, p. 96, emphasis added). The idea of enactive anticipation highlights three important aspects of perception, namely, that one's readiness to act in one's environment is autonomous, embodied and non-representational. Which means that perceptual anticipation is a product of one's previous engagements with one's surroundings and that it is intrinsically dependent on one's morphological features. Moreover, precisely because of its embodied and autonomous character, it dispels representational content. More recently, Gallagher and Rucińska flesh out the idea of enactive anticipation as a feature of cognition itself (not only perceptual consciousness). They write that 'protention is likewise an aspect of the intrinsic temporality of the embodied and enactive cognitive system, and of action itself' and that

[10] This provides another parallel with ecological psychology. Not only Gibson agrees with the claim that perceptual events are temporally structured (Gibson, 1966b, 2015), he also blurs the distinction between perception and memory (Gibson, 1966a). Recently, Stepp and Turvey (2015) argued for the prospective character of current perceptual experiences, developing a law-like ecological account of anticipation as well. All of this further approximates ecological psychology with the idea of anticipation discussed here. Noticeably, Gallagher is also aware of this proximity and frequently relates the Husserlian 'I can' with affordance selection as possibilities for action (e.g. Gallagher, 2016, 2017b; Gallagher & Rucińska, 2021). I believe these are all valid and potentially productive approximations—as I believe combining enactivism and ecological psychology generally is—but I refrain from discussing them in further details here due to my focus being on enactivism.

it ‘characterizes the enactive, dynamic organism-environment coupling; it contributes to the constitution of a dynamic experience of temporality that affects the organism’s interaction with its environment’ (Rucińska & Gallagher, 2021)—an idea they refer to Varela (1999).

We can relate the three aspects of enactive anticipation (autonomy, embodiment and lack of representational content) to Thelen and colleagues’ findings regarding the development of habits. For the interwoven embodied habits that arise and become self-sustaining during development inform the anticipation that is an integral part of our current perceptual processes. Again, all of this explains organism-environment engagements without calling for mental representations.

The import of this discussion to our present case is that infants develop embodied habits, understood as self-sustainable sensorimotor loops, which in turn are honed for engaging with physically well-behaved scenarios. During the experiments discussed in section 2, especially during habituation phases, when nothing extraordinary happens, there is a further reinforcement of the infants’ perceptual habits. Remember: in habituation phases and in some test conditions, there is no trickery involved, there are no floating blocks, disappearing toys or sticks that are move in synchrony. In those cases, perceptual habits that arose previously under normal or typical physical conditions are in place. But then those habits become critically challenged when the subjects face atypical scenarios, which were intentionally designed by the experimenters to be very different from normal conditions. Thus, an increase in mean looking time in those cases does not need to imply an innate representation of how things should be, but a breaking down of a habit due to a frustrated enactive anticipation (or, in phenomenology parlance, unfulfilled protention).

That same idea can be thought of in a different direction. It might look sensible to think of surprise as an indication of representational content to the extent that we take perception to be a snapshot of states of affairs. But this involves neglecting the facts that perception has a temporal structure, and that one’s previous engagements might become embodied habits that orient (constrain, enable, inform, etc.) current perceptual events. If

we take those elements into account, however, the temptation to infer representational content from behaviors of surprise is greatly diminished.

6. Conclusion

Do babies represent? If they do, the radical enactivists' explanation for the emergence of higher cognition is threatened, for it suggests that actively taking part in sociocultural environments and using publicly shared symbols is the key to higher cognition in a developmental scale. But the experiments discussed in section 2 indicate that pre-linguistic children act surprised when faced with atypical or outright impossible environmental settings. The representationalist explanation for that phenomenon is that infants inherited (or develop long before language mastery) the capacity to represent how things should be.

I have challenged that argument based on a criticism of the conjunctivist reasoning it seemingly endorses, for the argument in question only succeeds if representational content is assumed to be the mark of the mental, common both to typical and atypical engagements with one's environment. Although circularity can in principle be avoided—say, by withholding commitment to representational content as the mark of the mental—this move comes with a high price, because then the argument is no longer valid (which is not much better than being circular).

It seems that the main takeaway from this discussion is that sometimes empirical works developed under very general conceptual assumptions can miss the proverbial forest for the trees. More directly, the idea is that, once one already assumes (perhaps tacitly) that representational content is the mark of cognition, it is tempting to interpret certain experiments as lending independent empirical support for that conceptual view. In the case of our interest here, claiming that infants have innate (or early developed) representational abilities is a seemingly straightforward interpretation of experiments that measure visual surprise, *but doing so depends on the supposition of pervasive representationalism*. And this is logically flawed, as I have argued above. One can frame this matter in Kuhnian terms: normal science developed within a given paradigm should

not be taken to confirm the paradigm itself. At this juncture, as in other similar issues, a strategy available for the enactivist is to offer alternative interpretations of the relevant empirical findings that do not need to contest their empirical content, only their problematic philosophical consequences. With that in mind, I developed two congruent but independent enactivist-friendly explanations that focus on different timescales in order to show that, even in atypical cases, we do not need to construe surprise behavior as an indication of representation of how things should be.

Acknowledgements

I am profoundly grateful for two anonymous reviewers who made many acute criticisms and insightful suggestions for the improvement of this paper. Addressing them caused substantial and pervasive changes in this manuscript. I also thank my colleagues Nara Figueiredo, Sofia Stein, Raquel Krempel, Felipe Carvalho, Bernardo Alonso and Marco Aurélio Alves for discussing previous versions of this paper with me.

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