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The Emergence of Ur-Intentionality: An Ecological Proposal

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Abstract: Radical enactivism supports radical embodied cognition (REC), which is the idea that basic or fundamental cognition (perception and action) does not need to be understood in representational, contentful terms. REC departs from the idea that the mind can be naturalized through biological functions, but rejects the idea that mental content, which is understood as having a representational nature, can be naturalized. For REC, the natural origins of content (or NOC) is a program based on the following hypothesis: first, we depart from basic cognitive processes that are target-based and guided by an Ur-intentionality or directedness toward the world, and then sociality enters in the picture when language appears into the scene, allowing for establishing full-blown semantic content in which that content is about worldly states of affairs. Here, I am going to focus on the phenomenon of directedness since there are blind spots in this picture: as many authors claim, REC takes Ur-intentionality as the starting point, but there is simply no explanation to date of how this directedness or Ur-intentionality is established. Therefore, how could we account for Ur-intentionality? How does this kind of intentionality emerge? We believe that we can answer this question if we invoke the best scientific evidence from ecological perceptual learning especially in regard to the role of the environment and the information for perceiving affordances in our learning processes. This allows us to offer an answer to the question of how the most basic form of cognition (Ur-intentionality or directedness) emerges in nature.

Keywords: intentionality; ecological psychology; content; radical enactivism; naturalism

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1. Introduction

If a frog eats flies, what is in the frog's mind (the content of that thought) when it perceives and tries to catch them? Is the content a representation that refers to flies, or to little moving spots, or to something nutritious? Since the last decade, radical enactivism has aimed to delve into the program of the naturalization of content, offering its own conceptual resources. Radical enactivism supports radical embodied cognition (REC), which is the idea that basic or fundamental cognition (perception and action) does not need to be understood in representational, contentful terms. REC departs from the idea that the mind can be naturalized through biological functions, but rejects the idea that mental content, which is understood as having representational nature, can be naturalized. This has been delineated through what they call the natural origins of content, or NOC, which is an ambitious research program that aims to explain the transition from basic cognition to complex cognition. Each kind of cognition has its own distinctive kind of intentionality. Thus, intentionality is divided into two kinds: (1) basic cognitive processes are understood in terms of Ur-intentionality, or goal-directedness, i.e., intentional states based on biological functions without content (this is, pure target-based directedness), and (2) intentional contentful states that are about worldly affairs, which enter into the scene with linguistic practices [1,2]. While RECers have put a lot of effort into explaining the transition from Ur-intentionality to full-blown intentionality, there is simply no explanation of how this directedness or Ur-intentionality emerges. Therefore, the challenge is the following: What would be a complete account of how Ur-intentionality or directedness intentionality

emerges? The importance of learning (more specifically, perceptual learning) is at the very basis of the origins of subjectivity and behavior. In sum, a key step in order to establish an ecological naturalization of the human mind consists in re-evaluating up-to-date theories of perceptual learning and to fill in the gaps of their explanations, complementing them with the best scientific evidence from ecological perceptual learning [3–5], especially in regards to the role of the environment and the information for perceiving affordances in our learning processes. This allows us to offer an answer to the question of how the most basic form of cognition (Ur-intentionality or directedness) emerges in nature.

To achieve our goals, Section 2 depicts REC and the NOC program. Section 3 deals with some criticisms against the NOC and points out the pertinence of the question of how Ur-intentionality emerges, while Section 6 shows how ecological psychology, and specifically the direct learning framework, helps us to answer the question of how Ur-intentionality is established via perceptual learning.

2. Radical Enactivism and the Natural Origins of Content (NOC)

Since the cognitive revolution in the 1950s, cognitive science has developed in many different and often incompatible ways. Nowadays, the scene resembles a complex mosaic consisting of all kinds of colors and shapes. One big group of the theories that make up this mosaic falls under an increasingly popular research program, namely, 4e cognition (embodied, embedded, enacted, and extended). This label, however ambiguous, groups several commitments that force the theories adopting them to nuance or reject the main tenet of the classical computational theory of mind (CCTM): that cognition is the performance of (digital) computations over a set of symbolic representations that can be combined by syntactic operations [6].

Nevertheless, the departure from CCTM need not reject such central notions as computation or representation (see, e.g., [7]). In fact, some popular approaches to cognitive science that take the four e's of cognition seriously still maintain that cognition entails representations, even if many kinds of representations are to be understood as action oriented or situated [8,9].

On the other hand, some perspectives have been conceived in conflict with the core of cognitivism. Varela et al.'s *The Embodied Mind* (*TEM*) inaugurated the now widely popular enactive approach. In their own words, "the enactive approach consists of two positions: (1) perception consists in perceptually guided action and (2) cognitive structures emerge from the recurrent sensorimotor patterns that allow action to be perceptually guided" ([10], p. 173). Enactivism, as conceived by the authors, is concerned with different cognitive structures than those studied by cognitivism. In particular, the enactive approach seeks emergent cognitive structures that self-organize according to interactions between the organism and the environment, while cognitivism focuses on internal states that represent absent or imperfectly accessed properties of the environment [11].

However, since the publication of *TEM*, enactivism has become a many-headed hydra. Different approaches can be found according to their main focus and commitments. In particular, three approaches rule the game: autopoietic enactivism, sensorimotor enactivism, and radical enactivism. The first takes up the project of *TEM* of grounding cognition in the biodynamic of living organisms; specifically, it focuses on the idea of self-organization as the means for the emergence of cognitive structures. The second is usually presented as being concerned with the intentional and phenomenal characteristics of perceptual experience, which are accounted for as the result of sensorimotor patterns that relate sensation and embodied activity ([11], p. 369). The third concentrates its efforts in assembling a unified research program that rejects representational accounts of cognition in favor of embodied and non-contentful relationships between the organism and its environment. Nonetheless, this is not the place to discuss at length the varieties of enactivism, for in this paper, we are only concerned with one: radical enactivism.

Radical enactivism is not to be thought of as a competing and fully articulated variety of enactivism with its own set of explanatory tools. Rather, it is a general theoretical frame-

work that aims to unify and radicalize existing anti-representational accounts of cognition by a process of philosophical clarification [12]. However, radical enactive cognitive science (REC)[1] also targets some well-known representational theories, such as standard versions of teleosemantics. Therefore, it may be more accurate to say that REC is an attempt to radicalize and unify a wide variety of theoretical proposals in the cognitive sciences and the philosophy of mind under the same anti-representationalist flag.

But what about this flag? What is the specificity of REC's anti-representational approach? In their seminal book, namely, *Radicalizing Enactivism*, Hutto and Myin targeted a widespread thesis in the contemporary sciences of the mind: that cognition necessarily implies content (CIC)[2]. The radical line developed by Hutto and Myin has attempted to account for the nature of basic cognition, i.e., mental activity that exhibits intentional directedness but does not necessarily imply content. Thus, according to this view, perception and action are inherently contentless activities. These authors think that most of our cognitive activities, as well as those of other organisms, are better understood as dynamic and embodied engagements with wordly offerings that do not require contentful representations of features of the environment [13].

This is not to deny that content is not necessary at all. There are, in fact, many activities that require it according to the authors ([13], p. xviii). Rather, REC's point is that we must not build our theories upon a primitive notion of content whose role is to explain cognition as such. If we think of the activities of basic minds as consisting in content manipulation, we are missing something crucial, namely, the specificity of enculturated minds. Hutto and Myin believe that affairs such as linguistic practices are the paradigm of contentful activities, for they exhibit properties like reference, truth, and implication. In these cases, satisfaction conditions can be specified and met, and this is just what we need to talk about content. Thus, basic cognition accounts for something more modest than content. And, more importantly, it accounts for something on which content can be built.

There is more, however, to REC's dismissal of CIC. Up to a point, any theory committed to it must face what Hutto and Myin [13] call the hard problem of content. In a nutshell, the hard problem of content states the incompatibility between an explanatory naturalism and the positing of what is commonly understood as informational content[3]. These authors state that what is usually discussed under the label of informational content is nothing but contentful. This point is quite important for REC's non-representational approach, for cognition, according to many defenders of CIC, is precisely the manipulation, coding, or processing of informational content. But, if what is manipulated lacks the features to count as contentful, are we not presupposing what we are trying to explain?

Hutto and Myin's concerns about the notion of informational content stem from the way in which the notion of information is used in informational semantics. According to them, the notion of information that is at stake here is one of information-as-covariance. Some examples will help to obtain a grasp on it. The number of rings in a tree trunk is said to carry information about the tree's age; a fingerprint conveys information about the identity of the person whose fingerprint it is; smoke bears information about there being fire. All these cases can be brought under a common formulation: s's being F conveys information about t's being H if, and only if, the occurrence of these states of affairs covaries in a lawful or reliable enough way ([13], p. 66).

Nevertheless, if something is to be regarded as content, it must meet some stipulations. For instance, to name just a few, it must have truth conditions, reference, and inferential relations. But covariance relations between states of affairs, according to Hutto and Myin, do not meet the required constraints: they are logically distinguishable from content, which is *sui generis*. In their own words, and citing their passage at length:

> The number of a tree's rings can covary with the age of the tree; however, this doesn't entail that the first state of affairs says or conveys anything true about the second, or vice versa. The same goes for states that happen to be inside agents and which reliably correspond with external states of affairs—these too, in and

> of themselves, don't "say" or "mean" anything just in virtue of instantiating covariance relations. ([13], p. 67)

Hutto and Myin call this the covariance does not constitute content principle. If it is accepted, defenders of CIC can be charged with confusing information-as-covariance and information-as-content, with the latter being understood in terms of propositional content. This is essential to REC's argument, for, in that case, the emergence of content in nature must be explained and not just presupposed. An explanatory naturalism cannot accept that content is found in nature in the form of covariance relations between states of affairs. Recall that this belief was just what the hard problem of content targeted. Thus, naturalism is faced with a dilemma: either retain the concept of information-as-covariance—which is scientifically respectable—while denying that there are any informational contents to bear or accept that there are truly contentful states that cannot be reduced to covariance relations, whose content needs to be explained in a naturalistic vein. At this juncture, REC is concerned with the second point of the dilemma. Naturalism shall not give up on explaining the origins of content. Here comes the positive part of REC's critique of representational approaches to cognition. Hutto and Satne [1] proposed some enactivist makeovers that allow for the search of content in the natural world in a way that avoids the main difficulties faced by the proponents of CIC. We refer to this research program as the natural origins of content (NOC). In what follows, we discuss its main features.

The NOC program aims to provide a general framework for explaining the origins of content. There are several worries that led Hutto and Satne [1] to propose this lead. Here, we cannot discuss at length all the particular critiques to existing research programs that these authors have put together. However, following the thread of what we have been saying, we are able to understand Hutto and Satne's general worries. First of all, recall that REC has criticized any attempt to find content at a certain level of complexity. This was the whole point of the denial of the assimilation between content and covariance relations. Hutto and Satne thought that some proposals for the naturalization of content fall under this trap. This is, for instance, the case of teleosemantics, which accounts for content at the wrong level ([1], p. 529). Other approaches to the game of naturalizing content have not gotten too far either according to the proponents of the NOC program. Neo-behaviorisms of the sort of Dennett's intentional stance have failed to give us a history about the emergence of the content-ascribing practices that intentional agents exhibit. Moreover, they have not succeeded in making clear the differences between the kinds of intentionality possessed by both intentional agents—i.e., those who ascribe mental states—and intentional patients—i.e., those who are subjects of the ascriptions ([1], 531ff). Another proposal in the game, namely, neo-pragmatism, has not received much more luck. By deriving contentful states from sociocultural practices, it has committed its defenders to an essential tension: if those normative practices are themselves contentful, how can content be said to come to the scene in the first place? In addition, neo-pragmatism has confined intentionality to those beings capable of engaging in normative practices, denying it to a wide range of organisms in the natural world ([1], 528ff).

Therefore, what is the solution that the NOC program offers us? We are now in a position to fully understand how these critiques relate to the main ambitions of REC. Hutto and Satne believed that all these attempts share a presupposition, namely, that to have intentionality is to have semantic content. For this reason, teleosemantics, neo-behaviorism, and neo-pragmatism all play the wrong game. Instead of trying to naturalize semantic content, they should be playing the game of the natural origins of content. This game has some new rules to assimilate. In the first place, intentionality must not be equated with semantic content anymore, for, as maintained by the authors, intentionality is not "all of a piece" ([1], p. 529). Along with intentionality that exhibits *aboutness* and semantic content, a new kind of contentless intentionality that only exhibits *directedness* is to be distinguished. Hutto and Satne call this type of intentionality "Ur-intentionality"[4].

If this kind of intentionality is accepted as a new player in the game, things may look a bit different for the old players. Foremost, teleosemantics would need to be replaced by

teleosemiotics. Hutto and Satne thought that explanations that appeal to natural selection to account for the way in which current organisms respond to specific features of their environment have something right. Teleosemiotics would be the way to retain this hit while avoiding fixed content attributions to representations. This move would dodge the problematic consequences that content attributions have at the level of biological function. According to the NOC program, the tools from biology suffice for explaining Ur-intentionality, that is, the directedness that evolved structures exhibit toward their environment. Neo-behaviorism and neo-pragmatism would look different too. The former would need to acknowledge the distinction between Ur-intentionality and intentionality that displays aboutness. In this fashion, the nature of our content-ascribing practices could be clarified, for the distinction between intentional agents and patients could be treated as the distinction between organisms that exhibit semantic intentionality and those who exhibit Ur-intentionality, respectively. The latter, namely, neo-pragmatism, would not need to commit itself to an essential tension. Recognizing the existence of the contentless Ur-intentionality could be the way of providing a more basic form of cognition on which contentful states could be said to be built atop. In this way, according to the NOC program, it would be the task of neo-pragmatism to explain how Ur-intentionality and the kind of intentionality displayed in normative practices are related. This would bridge the gap between the two. These are, thus, the main promises of the NOC program. In what follows, we are concerned with some of them. Specifically, we test the account of Ur-intentionality branded by the NOC program.

3. Problems with the NOC and the Emergence of Ur-Intentionality

As we have seen, the NOC is a research program that aims to explain how content emerges as a natural process during the development of the individual thanks to subpersonal mechanisms produced by successful adaptation. This allows organisms to develop certain abilities that allow for the establishment of two kinds of intentionality: directedness and aboutness, or Ur-intentionality and proper intentionality. Ur-intentionality is a step in between the mechanisms that we acquire with evolution and the establishment of proper intentional content. Once we receive the mechanisms via evolution, we put them to work in the world and we acquire Ur-intentionality, also known as a certain directedness toward targets, and then we start from that Ur-intentionality to make sense of how intentional content emerges thanks to socialization practices and mechanisms (rule following, social conformism, imitation, etc.).

Thus, according to the NOC program, the task consists in "explaining Ur-intentionality by appeal to the selective pressures that will have operated on ancestor organisms" ([1], p. 531). These pressures give rise to mechanisms and these mechanisms allow the organism to develop certain abilities or capacities for being directed to the world. This shows "how there can be a form of intentionality and thus intelligent responding that doesn't presuppose the existence of content from the get go" [1]. And there is no content at that stage because that directedness is based on pure extensionality granted by evolutionary mechanisms.

Biological explanations can tell us what ancestors of a particular sort of device did, in fact, target, and thus, what fixed the range of things descendant devices now respond to, extensionally speaking. Thus, biology provides adequate tools for making sense of something more modest than content—it provides what is needed to understand and explain responses exhibiting a kind of Ur-intentionality that results from the targeted directedness of past organisms ([1], emphasis added).

However, it seems that according to some authors, radical enactivism and the NOC program offer no concise explanation for the establishment of Ur-intentionality as a cognitive phenomenon—they only appeal to evolution for that. According to these authors, there is simply no explanation of how this directedness or Ur-intentionality becomes the most basic cognitive process [16,17]. Their main concern can be summarized in the idea that while Hutto and Satne appeal to the "targeted directedness of past organisms" and

"what fixed the range of things descendant devices now respond to", there is no full-blown explanation of this.

For example, Abramova and Villalobos [16] (p. 654) claim that "[the proposed Ur-]intentionality, even if contentless, is similarly a case of anthropomorphic projection that cannot explain the origin of semantic content". According to these authors, Hutto and Satne projected our uniquely human intentional capacities to every kind of organism and, even if they do it without appealing to aboutness, only directedness. On the other side, Rowlands [17] claimed that there cannot be something like Ur-intentionality in the first place since we cannot establish relations of directedness toward objects simpliciter (this is, responding to objects extensionally speaking) since every object, even the simplest one, appears to ourselves under a mode of presentation (which makes the relation to objects simpliciter impossible). For example, in the case of a frog perceiving a fly, a fly is perceived thanks to a mechanism by which "the relevant states of the mechanism are also related, in precisely the same way, to fly stages and undetached fly parts", which means that "Ur-intentionality [directedness to an object] can only be specified if we know the mode of presentation under which it falls" ([17], p. 743).

We are not going to delve into arguments against Abramova and Villalobos' or Rowlands' arguments against Ur-intentionality, which seem to be a kind of rejection against the pure idea of such kind of intentionality. We think that the idea of an Ur-intentionality as prior and as a necessary step toward a full-blown intentionality is promising, but we claim that there are further arguments to challenge the picture of Ur-intentionality offered by Hutto and Satne in the NOC program. First of all, we can ask which view of evolution supports their approach to the evolutionary origins of content since there are at least two views in dispute that illuminate and emphasize different aspects and mechanisms. These two views, namely, modern synthesis (MS) and extended synthesis (ES), rely on different evolutionary mechanisms and forces: whereas MS solely includes natural selection, ES includes natural selection and other processes and evolutionary mechanisms, such as niche construction or epigenetics, to offer a complete multidimensional approach to evolution. Supporting one view or another implies that there are different emphases in what is pertinent for offering a full-blown approach to the evolutionary origins of cognition, because it determines where we should focus our attention regarding this issue: Is it the whole organism as capable of adaptive behavior what we should focus on, or should we focus on genes and/or the etiological origins of functional mechanisms of parts of those organisms?[5] What is the unit of selection in the evolution of cognition? A more explicit commitment is needed within the NOC framework for elaborating on the idea of which are the "biological explanations" and the "adequate tools" to which RECers appeal to make sense of the evolution of cognition.

But there is another argument that we consider more important, or even decisive for articulating Ur-intentionality. Even if we agree with the original picture of Ur-intentionality offered within the NOC, we should ask ourselves how these inherited mechanisms, features, and capacities for establishing that directedness appear or are implemented in the ontogeny or developmental history of the organism that possesses them; that is to say, how does the capacity for directedness appear within the developmental history of the organism? What is needed for such an organism to have that directedness or Ur-intentionality established as a part of its cognitive repertoire? This is the same as asking how Ur-intentionality emerges. Merely pointing to mechanisms and features inherited by evolution is not enough since merely pointing to them does not explain how particular organisms acquire the abilities allowed by the mechanisms: for example, a human can be born with an intact neurotypical brain, but if such a human lacks a suitable social environment for developing language skills, the brain areas associated with language skills become useless for developing such skills. In this sense, we have to ask what is needed in the development of an organism for acquiring Ur-intentionality, and this is exactly what, as we see it, Hutto and Satne did not offer. In the rest of the paper, we want to fill in this critical gap by pointing to ecological psychology and the theory of direct learning as a key tool for filling in this explanatory gap.

4. An Ecological[6] Proposal for the Emergence of Ur-Intentionality

4.1. Post-Cognitivist Approaches to Perceptual Learning: Enaction and Ecological Psychology

Up to this point, we have sketched the main goal of the NOC and we have focused on how postulating Ur-intentionality is an essential previous step toward the naturalization of mental content. However, our main concern is that there is no satisfactory explanation of how Ur-intentionality is developed or how it appears beyond pointing to the mere evolutionary equipment we are born with. In the previous section we show how this is insufficient, as having these mechanisms or equipment is by no means enough for developing or establishing a skill or capacity. We must turn our eyes to the scope of development and learning because it is in a rich environment where those mechanisms are operational and allow for the consolidation of an organismal skill. If so, we have to make sense of the emergence of Ur-intentionality through perceptual learning and development.

What would be a complete account of how Ur-intentionality or directedness intentionality emerges? The importance of learning (more specifically, perceptual learning) is at the very basis of the origins of subjectivity and behavior. Leaving aside traditional cognitivist approaches to perceptual learning, post-cognitivist (that is, non-representational, embodied, and situated) approaches have blossomed in recent decades [20]. We can divide them into two main groups: ecological and enactive approaches. Both of them have in common the idea that perception and action are tightly related phenomena, or even two sides of the same continuous process that establish a history of interaction with the environment that gives rise to a particular kind of embodied, implicit, or non-discursive skillful knowledge. Regarding enactive approaches, perceptual learning is based on mastering the sensorimotor contingencies through which we navigate the world [21]. One of the most influential and innovative approaches to perceptual learning can be found in the work of Di Paolo, Buhrmann, and Barandiaran [22]. Higueras-Herbada et al. [5] defined their approach to perceptual learning through five main points: (1) representations are not needed to perceive and act; (2) learning processes transform or modify perception instead of constructing it: it is a process that departs from perceiving, and then is followed by the modification of previous states, developing the perceptual process into new forms and versions; (3) perceptual learning is taken to be both action-based and world-involving: the first refers to the idea that perceptual learning implies effort on the side of the learner, and the second points to the idea that perceptual learning "involves a relation to the dynamics of the world beyond the mere supply of sensory input" ([22], p. 80); (4) perceptual learning needs so-called "adaptive mechanisms" with feedback that includes normative evaluations, which allows the agent to evaluate the correction of its own perceptual state, which opens the door to allow the agent to learn from previous processes via feedback evaluation; (5) and lastly, learning is a never-ending or open-ended process in which agents or organisms adapt to the perturbations of the environment and try to deal with new, unexpected situations. All five of these points were implemented scientifically via computational modeling in the case of Di Paolo, Buhrmann, and Barandiaran [22].

On the other side, ecological approaches to perceptual learning have been present in the theory since its very birth in the mid-1950s. Eleanor Gibson (who founded the ecological approach, along with James Gibson) has been a leading figure in the field of developmental psychology and perceptual learning. Ecological psychology is an embodied, situated, and non-representational approach to perception and action that developed its own scientific and methodological framework to be applied to in vivo experimental setups, gathering a vast corpus of experimental evidence over the last 70 years in optics, touch, haptics, development, comparative psychology, etc. The key aspects of the ecological approach are the following: first, an ecological scale or level of explanation that comprises the behavior of the agent and the information of the environment as the main unit of analysis (what they call an agent–environment system); second, an analysis of informational variables of the environment as higher-order variables available to be extracted by the perceiver through exploratory action; third, the use of a sophisticated mathematical apparatus (such as dynamical systems) for explaining how organisms extract or pick up such information.

In this sense, it can be argued that ecological psychology is a theory of Ur-intentionality at the level of the individual organism, and that is precisely why direct learning is crucial for addressing the ontogenetic problem of Ur-intentionality. See, for example, the work of Segundo-Ortin et al. [23] on the overall compatibility of radical enactivism and ecological psychology, where they claimed the following:

> "According to radical enactivists, the way Gibsonians describe perceptual information leads to positions that are akin to the ones offered by representationalists (…). In summary, they find three main issues in the Gibsonian approach: first, the idea that perception requires picking up information from the outside world; second, the idea that this information specifies or is about the environment and the affordances present within it; and, third, that this information is meaningful. In light of this, radical enactivists conclude that EP is not radical enough as it stands and that it needs to be "RECtified"—that is, "sanitized" of its representational commitments (…). Contrary to this view, we have argued that the notions of 'information,' 'specificity,' and 'meaning,' if properly understood, do not entail a commitment to the existence of informational content in the world and, thus, that EP is not in conflict with the principles of the radical forms of embodied cognitive science. First, we have argued that perceptual information as conceived by EP is to be related to the organisms that inhabit a particular eco-niche. (…) According to Gibsonians, perception requires the detection of invariants—that is, structural patterns which remain constant beneath transformations. Because an invariant can only be detected against a particular transformation, invariants as key informational variables only become available through the active exploration of an environment by an agent. In the absence of particular organism–environment interactions, invariants are not available in the environment to be detected. Both reasons, considered together, cast doubt upon the idea that perceptual information is simply outside in the world, independently of organisms. After clarifying the nature of the perceptual information posited by EP, we have discussed whether describing this information as being specific and meaningful entails that this information is of a contentful kind. As we have argued, the notion of specificity refers to the lawful, 1:1 relation between invariant patterns in the ambient array and aspects of the organism– environment interaction. As such, specificity can best be understood as lawful covariation, without any assumption that it carries content. Invariants covary with the environment and the affordances present in it, but they do not convey anything true or false, veridical or non-veridical, and so on about them. Finally, we have explained that the notion of meaning as used in EP is to be related to affordances. Perceptual information, hence, is said to be meaningful for an agent or an organism because it affords certain opportunities for interaction to her, but this meaning is orthogonal to semantics. In light of these arguments, we conclude that EP is radical enough and that it is apt to be included in a full-blown post-cognitivist approach to cognition.". ([23], pp. 16–18)[7]

Perceptual learning within cognitivism has been regarded as the enrichment of percepts [20]. Enrichment theories of perceptual learning pose a problem: if learning consists in enriching percepts, then the improvement of perceptual learning implies a constant diminishing of the role or importance of the environment. This idea was taken to the field of linguistics by Chomsky, who formulated the hypothesis of the "poverty of the stimulus", leading to the claim that focusing on stimuli is not enough to account for cognitive processes. In particular, Chomsky argued that the competent use of syntactical rules cannot be a matter of reinforcement learning alone; mental structures provide the locus of control of the language acquisition mechanism. This hypothesis has been key for the current versions of cognitivist approaches to perceptual learning processes. Thus, the enrichment hypothesis in perceptual learning is closely tied to the hypothesis of the poverty of the stimuli: if the stimuli are poor, they need to be enriched in learning processes, and the

importance of the environment diminishes with time as the agent learns. James and Eleanor Gibson opposed enrichment theories and vindicated the environment as an essential and constitutive element of perceptual learning processes [24]. Due to their rejection of inner information processing or computing mechanisms, they denied the need for claiming that enriching stimulus information was necessary for learning, and instead they claimed that perceptual learning should be considered as the *education of attention*, a process in which organisms refine their attention through exploring the environment in more efficient ways. In this view, the environment is always a key element that contributes to the cognitive development of the agent, and at the same time, the agent keeps relying on environmental stimulus information to perform their actions and explore. On the side of the agent, there is a process of attunement to informational aspects. As we can see, ecological approaches to perceptual learning imply a rejection of the cognitivist-inspired views of the enrichment of the stimuli. To counter this view, ecological psychology has been focusing on collecting empirical data to support the hypothesis of the education of attention. There is available evidence in topics such as the visual cliff experiment [25,26], affordance perception for displacement in infants [27], and crawling and locomotion within motor development [28,29]. Nevertheless, the view on perceptual learning within ecological psychology has been refined since almost twenty years ago. Jacobs and Michaels [4] combined the former ideas with dynamical systems theory to offer the direct learning framework. The direct learning framework represents the available higher-order informational variables within an information-calibration space, in which the learning process is viewed as a curve in this space that tends to more specific variables [5]. In this sense, novices and experts differ in the learning process depending on which informational variable they detect for guiding them in the performance of the task. Thus, the conclusion is that participants go from novice to expert when they educate their attention to pick up the most specific variable in the previously mentioned informational space. This move from less specific variables to more specific variables means that performance increases in terms of efficiency. As we can see, the ecological approach through direct learning inherits the idea of the education of attention and the importance of environmental information without relying on inner information processing[8], while at the same time, the hypothesis is solidly supported by strong empirical evidence [31].

4.2. Direct Learning and Ur-Intentionality

So, how can the direct learning framework help to illuminate the emergence of Ur-intentionality? As we have seen, Ur-intentionality is used for explaining basic cognition (perception and action, at least), and it is defined not as content-involving, but as target-based Hutto and Satne [1,2]. This means that the perception and action states do not rely on representations to fulfill their task. This has been an object of heated debate, and most of the critics have been responded to by the authors (see, for example, a great systematized recollection in Hutto and Satne [2]). Although there have been great developments for the NOC since its inception in the 4e literature (especially regarding social cognition; see especially Satne [32] and Segundo-Ortin & Satn [33]), as we pointed out in previous sections, Hutto and Satne did not offer a positive explanation of how this Ur-intentionality emerges, especially taking into account ontogeny or the individual's development. We accept the general outline that the authors offer regarding the NOC, and we want to contribute to it by offering a positive story of how this basic but essential step emerges.

As we have seen, if Ur-intentionality is target based, the main objective for this step would be to make sense of how this process of targeting appears. Merely appealing to biological inheritances is not enough, as we have mentioned, because that step leaves aside the individual development of organisms, which consists of *how those organisms aim at a target*. This seems to be what Hutto and Satne [2] did since they claimed that "Ur-intentionality can be explained by making theoretical adjustments to teleosemantics". The problem is that buying the whole teleosemantic framework, removing representations, and including contentless targeting processes instead does not seem to be enough to

account for ontogenetic processes of perceptual learning since the main reasons used by teleosemanticists to explain cognition rely on biological functions inherited via natural selection. Of course, there are biological functions inherited by natural selection, but *how a particular individual makes use of those biological functions for targeting* is something that is not explained, neither in teleosemantics nor in the NOC because both approaches do not delve into the field of perceptual learning for doing this. To illustrate it in another way, we can apply the strategy of Tinbergen and his famous four questions for explaining behavior: What is its function? How did it evolve? What causes the mechanism to be performed? How has the behavior developed during the organism's life? Teleosemanticists[9] and RECers focus *mainly* on the first two, but they also make room for learning and ontogeny when they acknowledge that "[t]o ward off another possible confusion, it should be clear that the history of attunements that fix the norms in question is not always directly tied to long tracts of ancient evolutionary history. [...] An organism's tendencies adjust as it gravitates toward an optimal grip on situations through individual learning. Such adjustments establish new transient norms for perceiving and acting, along with new anchors for attention, through an ontogenetic process of selection by consequences." ([35] 117 ff). As such, despite the compatibility with the account of perceptual learning offered by ecological psychology, it might be said that they have not supplied a detailed or robustly empirically informed account of how the education of attention might take place[10]. For this reason, we argue in what follows that the ecological framework of direct learning[11] within ecological psychology supplies this detailed empirically informed account of how Ur-intentionality emerges through the process of the education of attention, thus providing the missing answers to the remaining Tinbergen's questions.

As we have seen, direct learning is based on the idea that the organism faces an informational space, and its exploration leads it to pick up or extract information to achieve its goals. This has supposed a mathematical, empirically tractable approach to perceptual learning under ecological principles. Contrary to cognitivism, ecological psychology claims that we are constantly surrounded by a rich informational sea that we navigate through according to our interests. Through that exploration, we extract information via picking up pertinent higher-order information variables. This pertinence is related to our goals. Hence, picking up this or that variable can be less or more efficient for achieving its goal. Needless to say, no appeal to information-processing mechanisms or manipulation of representations are needed to make sense of how organisms explore and actively pick up available information in the informational space. In this sense, years of research have led to the empirical claim that individuals go through a very particular process from being novices at doing a task to becoming experts: novices pick up less specific variables than experts, and experts are so because they discard the rest of the informational candidates and pick up the most specific variables. This has been the case according to significant experimental evidence, from tasks like pole balancing [38], to avoiding or punching falling balls [39–41], and the lateral interception of moving objects [42]. The evidence strongly supports the direct learning framework and its claim that there is a learning curve from novices to experts that is guided by picking up more specific information and the increasing efficiency in doing so.

Now we can see how ecological psychology fills in those gaps: direct learning offers the tools to explain how the target is established and how organisms make use of the biological functions inherited to cope with the environment. First of all, target establishment is a process that is explained thanks to the learning curve: organisms have a goal to satisfy; then, they engage with different informational variables and try to satisfy the goal efficiently. When they move from less specific to more specific candidates, they go through a process of establishing the target to achieve their goal via picking up more specific (hence more efficient) information. Imagine a case of intercepting a moving object: while novices might fail or not catch the object as efficiently as experts because they rely on non-specific information (such as, let us say, the noise or the shadows), experts rely on a well-studied higher-order ecological variable, named tau. This variable tau, which specifies time-to-

contact, is defined as "the ratio of the optical size [of the approaching object] to the rate of optical expansion [of the same object during time]" ([4], p. 324). Thus, as an object approaches you, that object progressively expands in your visual field, with this progression being directly related to the velocity of the object. This variable informs about the so-called time-to-contact between you and the surface. Thus, detecting, extracting, or picking up this specific higher-order informational variable is the most efficient way to intercept a moving object or avoid crashing onto a surface. The establishment of the target is achieved via transitioning through less specific information toward more specific information to achieve a goal or task. Second, how to make use of the biological function inherited is an ontogenetic process of discovering the most efficient strategy to extract environmental information for targeting. This is related to which are the most efficient exploratory strategies for extracting those informational variables. This is tightly related to Reed's idea of action systems: Reed [43] proposed different action systems, starting from which could be considered their evolutionary function, where there are cases like the basic orienting system (which is the functional orientation toward the source of information, maintenance of posture, etc.), the investigatory system (or the exploration or particular movements for obtaining higher-order variables), and the locomotor system (which controls velocity of movement) ([43], pp. 112–116). These systems are not individuated through groups of muscles, but through two kinds of aspects: postures and movements. Postures are so-called "persistences" or orientations toward sources of information, while movements are transformations from one posture to another ([43], pp. 111, 118; [44], p. 139).

As we have seen, there are enough resources within the ecological approach to explain how Ur-intentionality emerges: first, if Ur-intentionality is target-based, and if we want to explain how that activity of targeting emerges, it is necessary to explain to which environmental elements is an organism sensitive to achieve its goals. Direct learning provides us with a wonderful explanation since learning to perceive is learning to establish a target via picking up the most specific variable for achieving a goal. Second, the way in which organisms apply their biological functions to achieve their goals during ontogeny and perceptual learning processes are understood within a general framework of action systems in which different orientations, postures, and movements are the basis for exploring, which leads to learning curves in the already mentioned processes of perceptual learning along ecological principles. These two ideas should suffice to fill in the gap of how Ur-intentionality emerges within the NOC program.

5. Conclusions

As we have seen, REC offers a general framework for making sense of the origins of cognition, which they call the NOC. The NOC is a research program that shows how we move from basic cognition to complex cognition, i.e., from target-based and non-contentful perceptual states to full-blown contentful, representational states (as in linguistic practices). Basic cognition exhibits Ur-intentionality (target-based directedness to the world), while complex cognition exhibits full-blown intentionality (semantic aboutness about worldly states of affairs). Despite the great developments in the literature since its inception, the NOC is still pending on answering one question: how does Ur-intentionality emerge? How is targeting established? Here, we have proposed that the emergence of Ur-intentionality is achieved through perceptual learning processes, which are exhaustively explained through the principles of ecological psychology; in particular, through the direct learning framework. This direct learning framework is especially relevant because it shows how targeting is established via a learning curve in which novices become experts thanks to transitioning from less specific variables to more specific variables. The embodied and situated credentials of the NOC are secured with the introduction of the direct learning framework since ecological psychology is an empirically informed, embodied, situated, and non-representational scientific research program.

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Notes

1 Hutto and Myin [13] use "radical enactive cognitive science" and "radical embodied cognitive science" as synonyms. In this paper we follow this lead, so "REC" stands for both.

2 To be accurate, RECers dismiss *unrestricted* CIC, not CIC as such: "CIC assumes that cognition requires the existence of contents of some kind or other. Unrestricted CIC takes this to be true of all mentality, always and everywhere." ([13], p. 9). However, for the sake of word economy, when we refer to CIC in this paper, we mean *unrestricted* CIC.

3 Hutto and Myin state the Hard Problem of Content as the incompatibility between an explanatory naturalism and the positing of informational content. However, this is not quite accurate, for they in fact assume the existence of informational content and its compatibility with naturalism. What they reject is the assimilation between covariance and content. That is why we state the Hard Problem of Content as being concerned with what is, according to the authors, *commonly* discussed under the label of informational content.

4 It must be said that Hutto, Satne, and Myin have not coined the concept of Ur-intentionality. They cite Muller [14], who discusses Sachs [15] on McDowell and animal minds. However, while Sachs only points to a logical distinction, these authors use this distinction as a desiderata for any theory accounting for the natural origins of content. We thank an anonymous reviewer for pointing this out to us.

5 This issue regarding the centrality of the organism rather than genes or populations is a very hot topic in contemporary biological theory debates. E-cognition approaches in principle should benefit the EES since both approaches strongly focus on the organism and its capability to adjust to environmental changes through flexible behavior. For more information, see Walsh and Heras-Escribano [18,19].

6 Along this paper, we use "ecological" to refer to the approach to perception developed by James and Eleanor Gibson, and to its forward developments since the 1970's.

7 Thanks to an anonymous reviewer for inviting us to reproduce the main conclusions of the analysis of Segundo-Ortin et al. [23] on the compatibility of radical enactivism and ecological psychology.

8 It must be noted that we do not claim that neural activity is not relevant for perceptual learning, or that a complete multi-level account of the phenomena must leave the neural scale aside. There is, in fact, some recent work in the ecological psychology literature that points to a way of describing the neural mechanisms involved in perceptual learning without relying on the concept of information processing (see e.g., [30]).

9 Millikan [34] discusses classical examples of perceptual learning in the literature of ecological psychology. We point to her discussion for a useful contrast between both approaches regarding this issue.

10 We thank an anonymous reviewer for pointing this to us.

11 One of the reasons that we prefer direct learning to the enactive approach to perceptual learning in Di Paolo et al. [22] is that ecological psychologists have gathered empirical evidence for supporting their claims since several decades ago using in vivo experimental studies in human beings, something that enactivists are far from doing, at least at the same scale than ecological psychologists. For more information on the differences between enaction and ecological psychology, see [36,37].

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