« 15 » The main idea is the following: if the ecological scale works at the personal level, the naturalization of subjectivity could be achieved by means of this scale. Affordances are present to agents at a personal level. Thus, ecological psychology could explain the way in which agents interact with their environments through the perception of affordances at a personal level thanks to the ecological, informational space. If these ideas are on the right track, we can draw the sharp line between the personal and the subpersonal levels.

« 16 » This has consequences for Gibson's rejection of subjectivity. If we understand subjectivity in an internalist way or as a Cartesian private space, we should reject it. But enactivism does not endorse this view when it aims to naturalize subjectivity. If we accept a simpler notion of subjectivity (that of the first person perspective), we can naturalize it at a personal level thanks to the ecological scale because, in the end, this scale explains how agents as a whole perceive and explore their environment. This implies no dichotomy or duality at all because no internalist element can be found in the ecological picture.

« 17 » Thus subjectivity can be explained as the first person perspective of the direct perception of affordances and also caused by the neurodynamics located at the subpersonal level that allow for the emergence of the personal level. This is precisely the work of Walter Freeman (2000), who aims to explain the role of neurodynamics in the perception of affordances, and it also reflects the ideas of Anthony Chemero (2009: 203) on how enactivism and ecological psychology could be combined.

« 18 » In order to stress the complementarities between both theories, something else could be said: the latter also accepts the ideas of the former on the relation between life and cognition. One example is the emerging field of plant cognition. As pointed out in §17, nowadays there is also clear evidence that the ecological approach can be applied to plant cognition (Carello et al. 2012). Traditionally, experts tried to make sense of plant cognition using neuroscientific vocabulary (through notions such as "plant neurobiology" or "root brains"), and aimed to find analogue, nervous-like structures in plants (Calvo & Keijzer 2011). Thus plant cognition was supposed to be explained only through a subpersonal level. But recent experimental results show that it is possible to apply the ecological framework to plant behaviour: climbing plants (*Phaseolus vulgaris, Leguminosae*) can control their movements thanks to tau/rho, which is a higher-order ecological informational invariant (Calvo, Raja & Lee 2015). In conclusion, the same personal level of analysis and the same kind of ecological patterns that we use in ecological psychology can be applied to plant cognition. Thus, ecological psychology offers a consistent and unified cross-species informational framework for explaining agent–environment interaction from plants to humans *at a personal level*.

Conclusion

« 19 » I aimed to reconcile enactivism and ecological psychology by showing how these two theories could complement each other. I believe that the best picture of this interaction includes ecological psychology for explaining the agential perspective or level *via* direct perception, while enactivism would provide an explanation for the subpersonal processes that shape agency through neurodynamics. Following this, the mutual cooperation between enactivism and ecological psychology in a single research program would be the best way to establish a consistent paradigm for the embodied and situated cognitive sciences, both at the personal and the subpersonal levels.

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Enactivism and Ecological Psychology: Divided by Common Ground

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> Upshot • Fultot, Nie, and Carello are correct that enactive researchers should be more aware of the research literature on ecological psychology, but their charge of mental construction is off-target. Enactivism and ecological psychology are compatible frameworks with different, complementary, emphases.

« 1 » Martin Fultot, Lin Nie, and Claudia Carello lament the manner in which the founders of the enactive approach dismissed James Gibson's ecological psychology without an adequate hearing. This dismissal has likely been responsible, at least in part, for the continuing lack of engagement by enactive researchers with the decades of theoretical and empirical literature that has been Gibson's work and legacy.

« 2 » I agree with the authors that enactive theorists should make themselves more familiar with the science of ecological psychology, but do not believe that their charge of mental construction being central to enactive thinking stands up to scrutiny.

« 3 » Examining the foundational work of enactive cognitive science – *The Embodied Mind,* by Francisco Varela, Evan Thompson, and Elenaor Rosch (1991) – the authors take issue with the description of the relationship between agents and their environment. In particular, Fultot, Nie, and Carello reject outright the idea that the agent constructs, or attributes, meaning to an otherwise meaningless environment. I think that Varela et al., and those enactivists who draw from their work, would agree.

« 4 » The question becomes how it might be that enactivists and ecological psychologists could be so strongly divided by this agreement. I believe the difference concerns the emphases within the different theoretical frameworks regarding two related things – history and individuality.

Not constructions, histories

« 5 » Both ecological psychologists and enactivists agree on agent-environment mutuality. The correct description of the environment that an organism inhabits, for the purposes of psychology or cognitive science, is that described from the point of view of that organism. The question is to what extent the existence of that environment as described depends on the specifics of the agent's own values, body, and actions. In this, I think the enactive approach tends to lay more emphasis on the particularities, the values and concerns of the agent. Ecological psychology encompasses such details too, but the focus of ecological research tends to be at a level of description where species-typical features are primary in the examination of lawful regularities between action and environment. Neither approach is *confined* in any way to these emphases, but they seem to dominate to various extents within each camp.

« 6 » The net result is that researchers from different groups feel that the others are missing the point, when what is actually happening is both are giving compatible and possibly even equally valid accounts of things, just at different resolutions of description.

« 7 » Varela, Thompson, and Rosch, and other enactivists following them, argue that the agent-environment system is an emergent phenomenon. As such, the environment at any given time cannot be stipulated in detail without reference to specifics of the agent and the history of the relationship between the two. Fultot, Nie, and Carello deny that the environment is so nebulous, and argue that a valid account of stable, essential features of the world relative to the agent can be offered, and should be the target of a proper psychological science.

« 8 » To illustrate within the domain of affordances, Fultot, Nie, and Carello offer the example of asking whether a doorway affords my passing through it, and argue that in the normal case the answer is "yes," regardless of whether or not I actually pass through it. It is vital that a science of psychology can make such generalisations, and it is a remarkable (and badly overlooked) strength of ecological psychology that it has captured many such generalisations with precision. But is also important to note that experience is continually sensitive to its own history. The particular perspective of the agent matters, and the generalisations are not the full story of any particular psychology.

« 9 » Take the doorway of Fultot's office in the Sorbonne in Paris. I have never seen it, but I am confident that it affords my passing through it. However, it does not afford my passing through it in the same way that it does for Fultot. Why? Because the history of actions that would be required to achieve that are dramatically different for me, requiring, for instance, the booking of a flight to Paris, getting directions to the building, and, perhaps, borrowing a key. The doorway continues to afford my passing through, whether, as they note in §15, I actually do so or not, but not in the same way.

« 10 » It is correct that there is something general about my relationship to the doorway of Fultot's office, but it is also correct that on any given occasion that I actually pass through the door of Fultot's office, the full account of that experience demands not just the generalities but the specifics of a given history.

« 11 » I suspect that ecological psychologists are at this point grinding their teeth in frustration at the obviousness of such observations, but it is precisely this difference in perspective, capturing what feels simultaneously trivial and definitional about experience, that enactivism wishes to keep within normal scientific discourse about the mind. A more explicit tacking back and forth between phenomenology as we live it in all its textured banality (also, glorious complexity), and the methodical search and testing of generalities, is precisely what an enactive science aims for (Thompson 2005).

« 12 » Part of what may be frustrating for ecological psychologists is that the importance of history and specificity are acknowledged within the framework. To make their point, Fultot, Nie, and Carello offer a quotation with which no enactivist could properly disagree:

> "In short, whether or not a potential stimulus becomes effective depends on the individual. It depends on the species to which he belongs, on the anatomy of the sense organs, the stage of maturation, the capacities for sense organ adjustment, the habits of attention, the activity in progress, and the possibilities of educating the attention of the individual." (Gibson 1960: 70)

« 13 » But enactivists are not alone in suggesting that ecological psychology has more work to do to acknowledge and address better the complex dynamics of individual, personal relationships between agent and environment that exist within their theoretical domain. Chemero (2009) argued that, despite ecological psychology adopting dynamical systems thinking root and branch decades ago, the complexity and the short-timescale variability of the agent-environment relationship has not yet been tackled as a core issue of consideration. While reliable characteristics of an environment perceptible by an animal have a lot to do with the evolution of the animal's econiche, the co-construction of an econiche is continually on-going, over the course of not only evolutionary but individual history. He suggests refining ecological discourse to include not just an evolutionary econiche but, as he terms it, the continuously developing phenomenological-cognitive-behavioural niche of a specific animal. Chemero explicitly notes that such an adjustment of practice would bring these two theoretical frameworks more clearly into line with one another (2009: 154).

« 14 » More recently, Erik Rietveld and Julian Kiverstein (2014) have argued that the notion of skill, and the socially constructed ecologies of normative practice that skills represent, offer a way to consider these individual variations effectively. Their skilled intentionality framework seeks to tackle issues of personal motivation and individual history in order to address the question of, as the quotation above has it, "whether or not a potential stimulus becomes effective" for any given agent in a given richly textured environment.

« 15 » Chemero's as well as Rietveld and Kiverstein's thinking are two examples of how enactive thinking and ecological psychology might meet. A familiarity with enactive thinking brings more emphasis onto individual dynamics to supplement, and complement, the kinds of generalities that have formed the primary focus of ecological research to date. This is certainly a question of emphasis rather than lack, however. Harry Heft (1989) made an argument about

the importance of the individual agent and their intentions shaping their relationship with the environment from entirely within the ecological framework, and before the publication of *The Embodied Mind*. (He has also made related points subsequently, see Heft 2007).

« 16 » While I agree that Varela, Thompson, and Rosch, in *The Embodied Mind*, do not adequately appreciate the richness of Gibson's theory, I would argue that most of the disagreements they raise with ecological thinking are actually just a statement of the above argument regarding the importance of this individual perspective in cognitive science – indeed, it is worth noting that they soften some of their criticisms in footnotes to the primary discussion, acknowledging the compatibility of the approaches where ecological laws are formulated in an agent-dependent manner; see chapter 9, footnotes 38 and 40. Fultot, Nie, and Carello are happy to acknowledge the value of individual history in understanding the specific activity (experience-behaviour complement) of an organism in its environment. What the individual "adds" to the environment in the perception of it, then, is not a set of inferences but interests that lead it to engage selectively with the world around it. No mental construction is needed, just a personal history.

The agent never encounters a meaningless environment

« 17 » But a crucial problem remains – that of an in-principle "meaningless environment." Fultot, Nie, and Carello are appalled by the idea that the organism is required to somehow create and attribute meaning to an otherwise meaningless world.[1] The terms of enactivists have it that the agent "brings forth a domain of significance," and that sounds like bad faith thinking to the authors; animal-environment dualist, representation-hungry, mental construction at its worst.

« 18 » Enactivists do not, however, suggest that perception involves the attribution of inferred meanings to an otherwise meaningless environment.

« 19 » To understand why enactivists are so interested in the idea of a "meaningless world," we should note the amount of attention given to the question of origins of life, mind, and meaning (Di Paolo 2005, 2016; Di Paolo, Rohde & De Jaegher 2010; Maturana & Varela 1987; Thompson 2007; Varela, Thompson & Rosch 1991; Weber & Varela 2002). Ecological psychologists can agree that in a world without agents, there can be no meaning. "The world of physical reality" after all, "does not consist of meaningful things" (Gibson 1986: 33). In wanting to understand consciousness, as the ultimate target of cognitive science, enactivists have attempted to answer the question as to how something so lop-sided as the first-person perspective could come into existence within that meaningless world. Trying to understand such dramatic transitions, enactivists look to minimal cases – minimal forms of value or concern (Weber & Varela 2002), minimal cases of agency (Barandiaran, Di Paolo & Rohde 2009), minimal forms of cognition and perception (Di Paolo et al. 2010). The question in all of these cases is how it could be that a purely physical world could become an ecosystem, how a world without concerns can come to have them.

« 20 » Understanding these transitions involves more than just spotting patterns in the dynamics. Having observed examples of no-concern and examples of concern, we should try to explain the difference between them, and in so doing define the subject matter of cognitive science. The enactive literature tends to focus on operational closure and the formation of identities that such a closure implicitly involves (Weber & Varela 2002; Varela 1997). Autopoiesis is considered one basic example of this that might offer a foundational understanding for the difference between cognition and non-cognition (though note that it is not the only one, and is not generally considered to be enough by itself: De Jaegher & Di Paolo 2007; Di Paolo 2005, 2009b; Thompson 2007).

« 21 » It may well be the case that Chemero's critique of autopoiesis in terms of non-well-founded set theory is fatal, as Fultot, Nie, and Carello argue in §36, I will confess I am not qualified to make that judgement. But it is not autopoiesis in-and-of itself that is doing the important work in identifying the transition point between a world that has concerns and a world that does not. What is needed is a strong foundation for precarious identity (Di Paolo 2016), one that can adequately explain the emergence of a first-person perspective, which in turn can form the basis for meaningful, individual, historied interactions between an agent and its environment, as we have already discussed. The complexities of thermodynamics as Fultot, Nie, and Carello have described them may ultimately be sufficient for that task, but the argument will not be based purely on the logics of physics, but on a defensible explanation of what makes agency agency, and how it can emerge from a world without it.

Conclusion

« 22 » Though researchers within the ecological and enactive perspectives on cognitive science have long been aware of one another, it would appear that this awareness has been marred by mutual misunderstanding. That ecological psychologists are galled by enactivists' failure to appreciate their work fully, given their historical precedence, is understandable. These two approaches have to a large extent, however, worked on complementary issues, driven by the enactivists' emphasis on the origins and structure of experience, and the ecological psychologists' emphasis on the structure of behaviour and the environment. These characterisations are admittedly crude, but I hope that they will do for the present limited purpose.

« 23 » More recently, the communication has become somewhat more positive. Chemero (2009) argued that the two approaches would be enhanced by more collaborative work. Ludger van Dijk, Rob With-

1 | It is worth noting that the enactive literature has gone through a couple of phases in the use of the terms "world" and "environment." In *The Embodied Mind*, the tendency was to refer to the "meaningless" physical aspects of things as the "environment," while the domain of interactions of the agent was the meaningful "world" its interests brought forth. In the past decade or so, the use of terms has switched, possibly because of the connotations of "environment" as implicitly referring to the agent – as that which surrounds the agent. Neither of these tendencies was entirely consistent, nor to the best of my knowledge, explicitly discussed or acknowledged anywhere in the literature. Noting the switch in tendency was a topic of a few conversations at enactive conferences though.

agen, and Raoul Bongers (2015) have called for enactivists to engage more with ecological work and noted the apparent compatibility between the approaches. These are sentiments I have echoed before (McGann 2014) and do so again now. While I have taken issue with the conclusions of Fultot, Nie, and Carello, I welcome their direct engagement with, and strident challenging of, enactive research. I think increasing such interactions can have benefits for both groups of researchers and the progress of cognitive science generally.

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Enactive affordances and the interplay of biological and phenomenological subjectivity

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> Upshot • Enactive approaches highlight the deep interdependency of brains, action, agency, and environment in shaping the world we inhabit. This perspective goes beyond input-output models of cognition, postulating instead closed loops of action and perception framed by the agent-environment complementarity. As a unique, dynamical, system, no (internal) representational recovery is required for cognitive-behavioral experience to take place.

« 1 » The target article by Martin Fultot, Lin Nie and Claudia Carello does an excellent job of introducing the main theoretical tenets of the work by James Gibson (1950, 1960, 1966, 1977, 1979). The authors present a clear description of his ecological psychology, stressing in particular his emphasis on the animal-environment relationship (§§8, 21) and, of course, the development of the notion of *affordance* (§§7, 13). From this background, the article advances a fierce criticism of the more recently emerged enactive approach to cognition (Varela, Thompson & Rosch 1991; Thompson 2007), maintaining that it fails to appreciate the hypothesis of direct perception endorsed by ecological psychologists (§29), and that it dangerously flirts with dualism (§36).

« 2 » My impression is that the authors are too dismissive of enactivism. In fact, when one considers the latter's roots in phenomenological philosophy, theoretical biology, and "action-first" perspective, it would be hard to find in the enactive thinking any leftover of dualism. Moreover, the embodied kind of "sense-making," through which enactivists describe cognition, does not require any representative subordination – being instead a concrete activity immersed in the dynamics of action of the living system. This, it could be argued, entails experiential directedness (see Beaton 2013).

« 3 » With this in mind, the enactive approach may offer a way of integrating ecological approaches to perception and experience more broadly (e.g., McGann 2014). This said, a closer alliance between such perspectives does not necessarily imply the annulment of their differences, which of course remain (more on this shortly). In this commentary, I will not explore the possibility of the development of a new, integrated, ecological-enactive science in detail. Rather, I will focus on how the enactive perspective describes the agent-world relationship, hoping to show that there is no radical incompatibility between the two positions in play, and – probably more importantly – that enaction does not entail representationalism, nor dualism, as Fultot and colleagues suggest. In doing so, I will introduce the notion of *enactive affordances* as a possible explanatory tool for bridging these approaches.

« 4 » The co-emergence of agents and environment is one of the most interesting and fascinating aspects of the enactive approach to cognition, as first put forward by Francisco Varela, Evan Thompson and Eleanor Rosch (1991). It captures the way enactivists frame the problem of experience: as agents we are not dealing with internal models of the world when performing a cognitive or behavioural task; we are, instead, *bringing forth* or, indeed, *enacting*, a domain of meaning. But what does that mean? Although this terminology is somehow "mysterious-sounding" (Clark 2016: 289), enactivists claim it points precisely to the main aspect of our being-in-the-world. It describes how autonomous agents like us act in, and shape, the world. Very briefly, it is argued that each ecologically-situated creature *co-constitutes* a world through evolutionarily-selected sensorimotor, and goal-directed, patterns of meaningful actions. Such embodied activity, moreover, results from the active dialogue between the agent and its environment. There is therefore a two-way exchange between world and living creatures, so that what is there for the agents is never fully determined a priori. It is instead dependent on the needs of each living system, which brings forth a world that is meaningful in terms of its continued survival and flourishing – a process that is adaptive and ongoing; flexible and open to constant change.

« 5 » Indeed, the enactive approach holds that bodily activity is crucial for cognition. As such, it emphasises the need to provide a biological account of the autonomous agency of living cognitive systems (Weber & Varela 2002). Here, the complementary focus on two types of subjectivity (biological and phenomenological) allows the enactive paradigm to be distinguished from other competing approaches in psychology, cognitive science, or philosophy of mind (Thompson 2007).

« 6 » The main problem, however, remains. What is "co-constitution"? How do we define the world we enact and share? Some help in approaching such questions, and conceptual clarification of the main issue, may come from the phenomenological tradition. According to phenomenologists, the world is…

> "never given to us as a brute fact detachable from our conceptual framework. Rather, it shows up in all the describable ways it does thanks to the structure of our subjectivity and our intentional activities." (Thompson 2007: 82)

The world reveals itself to me through my *active* participation in it: we are not in the world like water is in a glass, but in a completely different manner (Heidegger 1962).