

Facing life: The messy bodies of enactive cognitive science

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This is the accepted text. Forthcoming in *Phenomenology and the Cognitive Sciences*.

Abstract

Descriptions of bodies within the literature of the enactive approach to cognitive science exhibit an interesting dialectical tension. On the one hand, a body is considered to be a unity which instantiates an identity, forming an intrinsic basis for value. On the other, a living body is in a reciprocally defining relationship with the environment, and is therefore immersed and entangled with, rather than distinct from, its environment. In this paper I examine this tension, and its implications for the enactive approach, particularly the enactive conceptions of life and bodies. Following the lead of others, I argue that enactive cognitive science can benefit from a deeper reading and integration with extant work on the complexity and multiplicity of the living body within feminist philosophy and feminist science studies.

I Introduction

The enactive conception of life is the enactive conception of what it is to be a living body. In the existing literature there is a tension between two different conceptions of life, and therefore two conceptions of what it is to be a living body. One considers life as a *unity*, a whole defined by operational closure and the enactment of a boundary between the agent and its environment (this view emphasises the interiority vs exteriority of bodies, and allows for a particular assignation of agency; Thompson, 2007, 2011). The second is a life as *continuity*, in which the organism or agent is described as part of a system (the agent-environment system), and identifies itself not by a separation from the world, but by a valued orientation within it (endorsed by several authors, including Thompson, this

approach owes much to the philosopher Hans Jonas's view of living as metabolic activity; see Weber & Varela, 2002, but also Di Paolo, 2005, 2009). These two conceptions of the living agent are in tension with one another, at once dependent upon but also resistant to clear boundaries between the agent and its environment.

As is so often the case, there is no stable equilibrium point between these two complementary descriptions, and I will not attempt to offer one here. Rather, I will try to illustrate how this unresolvable tension provides one of the inherent characteristics of living - an orientation, a directedness, which is the basis for the enactive conception of value and meaningfulness of living systems. One of the core implications of this facet of the living body is the living agent's intrinsic complexity and the totality of its immersion in the world. The necessary implications here are that there can be no canonical description of the agent, and no exhaustive description of its relationship to its environment - hence there is no exhaustive description of the agent's actions. While perhaps somewhat daunting to consider, this indeterminacy of living being is something that provides the basis for agency itself. More usefully, in this paper I want to make clear how this view also brings into focus the ways in which enactive conceptions of the body have become aligned with feminist conceptions of the body, particularly in that work derived from Young (1980), Haraway (1987), Barad (2007) and others. The resonance between these related literatures offers some exciting resources for theorising bodies, values, and the relationship between agent and world.

In the next section I will provide a brief overview of the key considerations of bodies and living being as advanced by enactive theorists. A recent shift in emphasis sharpens a conceptual tension within enactive thinking between the *organisation* and *structure* of a living system. I will then explore the 'messiness' of real bodies, and the extent to which they are not simply 'unities', as they are often referred to by researchers working from an enactive perspective, but multiplicities. In acknowledging this I join with other recent works such as that of Nick Brancazio in recognising a coming together of enactive thinking and longstanding work in feminist philosophy. I then try to illustrate some of those relationships, paying particular attention to the work of Sara Ahmed and Karen Barad. This work brings out the importance of understanding living being not as distinct from the world (an articulation often used by enactive researchers), but as *oriented in the world*. It also helps us to understand a little more clearly the relationship between

organisation and structure. I close with some further implications and links to work on the understanding and interpretation of agency.

2 The Enactive Body

The enactive approach to cognitive science has always been an embodied approach, the inaugural work, by Varela, Thompson, and Rosch (1991) being quite literally entitled, *The Embodied Mind*. Despite this fact, or perhaps because of it, the conception of bodies within an enactive perspective has been under a continuous process of change throughout the subsequent development of enactive theory.

In *The Embodied Mind*, following Merleau-Ponty, the emphasis was placed squarely on the sensorimotor capacities of the living organism. Bodies were primarily characterised as the sets of skills that enable an agent of concern to manage its relationship with the world. This sense of bodies as sets of skilful concerns punctures many of the sacred axioms of Western psychology. The single, stable self is thrown over in favour of a complex of contextualised, specific engagements or entanglements of different kinds between the skilfully acting agent and the world around it. In subsequent work through the 1990s Varela (1991, 1997) continued to unpack the notion of a complex of interwoven processes with no definable centre, a "meshwork of selfless selves".

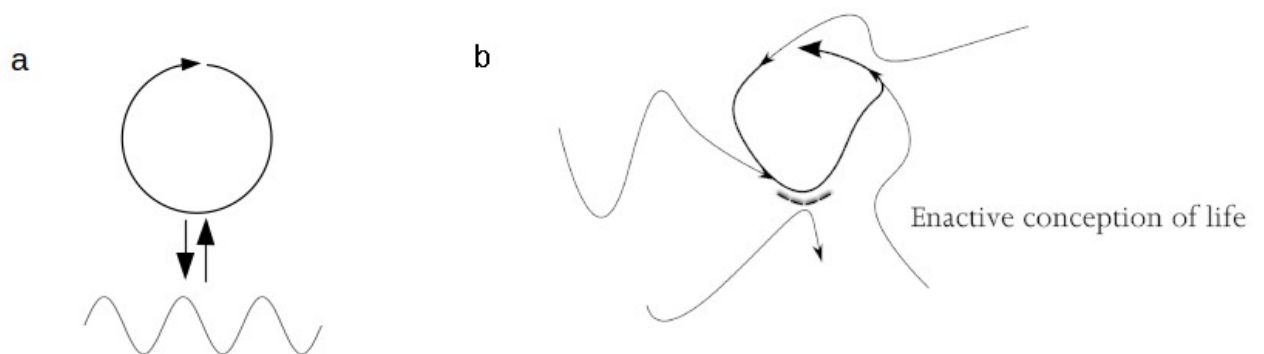
While evocative and appealing as an orientation, useful for shaking the cognitive scientific world out of the computational rut into which it had become stuck, it nevertheless remained something of a challenge to see how bodies as skilful capacities shared the kind of existential, purposive orientation to the world that seems inherent to our experience of it. Weber and Varela (2002) united the enactive approach with the earlier work of Maturana and Varela (1980, 1987), putting the self-distinguishing dynamic of *autopoiesis* in place as the organisation of concern or need that underlies the inescapable demand in the experience of living. Autopoiesis was identified as providing a value, something which can be lost and must be continually maintained against the threat of dissolution, and that orients and motivates the agent. The enacting body has not just the capacity, but the concern to act.

Di Paolo (2005) demonstrated that though the conceptions of body as skilful and as valued are a powerful complement, an additional facet is required to link the two. Di Paolo argues that a body must be adaptive in order for the binary, all-or-nothing distinction of

autopoiesis to be provided with nuance, to be transformed from a stark line between existence and death into a gradient of value. Different forms of adaptivity provide for different dimensions of value which enable an enactive perspective to account for the richness and complexity of lived experience.

Weber and Varela (2002) linked the enactive approach with the existential phenomenological work of Hans Jonas. Jonas identifies living being as an existence of *needful freedom*. A living organism not only has a capacity to act on the world, but is continuously driven to do so by the demands of maintaining itself against the inexorable tide of thermodynamic and other pressures. Di Paolo (2009) refined the enactive approach in line with this view, noting that agency must involve an autonomous system formed by a *precarious* network of processes of production, the precarious autonomous network of processes providing the needfulness, with adaptivity, as it were, providing the freedom.

Figure 1. a) The classical schematisation of autopoiesis as self-generating system, coupled with an environment. b) Di



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Paolo's (2018) updating of the figure emphasising becoming over being.

Di Paolo (2018) has offered a synthetic account of this approach in a book chapter entitled *The Enactive Conception of Life*, but which explicitly states early on that to answer this question is to address the question of “what is a body, in the enactive approach?” (Di Paolo, 2018, p. 72) Summarising recent work Di Paolo notes that the precariousness of living being necessitates a continuous process of transformation. He illustrates this with the use of diagrammes presenting relationships between living things and their environment which have been passed down through enactive writing from the early work of Maturana and Varela on autopoiesis. The original formulation of autopoiesis is typically diagrammed as a processual arrow turned back upon itself in a circle, illustrating the manner in which the system itself (rather than, say, an observing scientist) instantiates the distinction between itself and the environment (the environment is sometimes left out of this

illustration entirely, though is often schematised as the wavy line we see alongside the autopoietic circle in Figure 1a). Di Paolo updates the figure to note that a living being is in constant need of replenishing itself via its environment, and so is not so divorced from it, but rather is continually moving through it thanks to various processes of exchange (Figure 1b). Rather than a stable autopoietic circle we should better conceive and schematise the living body as one in a constant process of degradation and renewal, never stable, always partial and in a process of transformation. Rather than autopoietic *being*, the emphasis by enactive researchers following this line of thinking is now on enactive *becoming* (Di Paolo, 2018, 2022). This shift in emphasis is one that sharpens, I believe, an existing distinction in enactive thinking that illustrates the tensions between formal and more concrete, material conceptions of bodies.

Following Varela's (1979) *The Principles of Biological Autonomy*, enactive researchers have typically drawn a distinction between the organisation of a system on the one hand, and its structure on the other. The organisation of a system is a formal description of the set of relationships that hold between its components. The structure is the particular instantiation of the system in the domain in which it exists.

The classic example typically used is that of a living cell. The collection of chemical processes by which the cell produces and maintains itself can be written down and the relationships between the operating components recognised as being operationally closed (that is, being a web of processes that are mutually dependent for their continued operation). The cell itself also produces a *structural* boundary, the cell wall, which plays an important role in the physical maintenance of the cell's operations, but which is distinct from the formal closure that specifies the cell as an operationally closed system. The cell boundary is permeable in a number of ways *necessary* to the continued existence of the cell itself, and the processes that define the cell as a unity cross that cell wall, meaning that while the system is operationally closed, it is not structurally so.

Operationally closed systems effectively distinguish themselves from their environments, but not as separate physical structures closed off from the world. While somewhat distinct from the operational description, the structural description of a system still matters, indeed, in the case of living systems in which we are typically interested, the structural description is its *material* description. The structural particularities determine the

character of the system - its sensitivities and capacities, the range of particular transformations that are possible for it. In other words, its embodiment.

The laws of thermodynamics ensure that any operationally closed system must remain structurally open, else it will quickly run down and disintegrate. It is hard to overstate just how important this structural openness is to our understanding of agency and animacy, and as some enactive researchers increasingly emphasise the importance of understanding the materiality of bodies, this tension in our understanding of the organisation and structure of bodies is brought to the fore (see particularly Di Paolo et al., 2018).

A significant strength of the logic of autonomy on which enactive research leans heavily is that an operationally closed (and by extension, an autonomous) system defines itself - the system does not depend on the observer for its existence or specification. This provides the basis for claims of inherent values and agency which are absent in most other approaches to cognitive science and are a significant compelling motivation for enactive researchers. This self-distinction, however, is accomplished by the system within a given domain. Like any distinction, the figure depends upon the presence of a background. *From the system's perspective*, the act of self-distinction is not a formal process, but a material one achieved in a particular environment. Operational closure is the basis for autonomy in the formal domain, but the basis of *animacy* in the structural, material, one.

Formally, operational closure allows us to identify a system that distinguishes itself from its environment, and which constitutes itself as a unity within the environment. However, structurally, the system does not separate itself from the environment, but rather *orients itself within it*. Structurally, (which in the case of living systems presently known to us implies *materially*), operational closure creates an *asymmetry* in the universe. Once operational closure obtains, then the universe has direction of a kind which it did not have before, a flow of activity with distinct orientation as defined by the animating dynamic of operational closure on a system's structure.

Actual bodies, rather than formal schematisations of them, therefore tend to be rather messy.

3 The Messy Body

Real bodies are developmental things. They emerge through a series of transformations, all of them a shift from one whole to another. Enactive theorists often take the living cell as an example of an autonomous system; all multicellular creatures are therefore complexes of such systems. Insofar as the dynamics of adaptive autopoiesis are animating dynamics, then real bodies are multiply animated, complexes of such autonomous systems that are entangled with one another. And this is not simply by virtue of the number of cells. The organisation of those cells can in turn demonstrate such autonomy. Varela (1979) identified both the central nervous system and the immune system as autonomous networks, and it is likely the case that other component networks of a human body have an autonomous organisation too. While distinct (as autonomous systems are by definition) these systems are nevertheless entangled with one another in a way that produces the greater whole in which we, as cognitive scientists, are most routinely interested.

We might revisit Di Paolo's (2018) re-capitulation of the illustrative schema for the enactive body with this multiplicity in mind. In Figure 2a I have represented the complex living body not as a single self-distinguishing network, but as a collection of such networks entangled with one another. It is possible to perceive a coherent whole - either as a simple circle at the centre of things despite the fact that no such singular process is explicitly drawn, or a more complex set of curves - looking a bit flowery here - that would align with our capacity to perceive a single complex organism. This whole is not a just single system, however, and its component structure is not something that exists in stable equilibrium.

Di Paolo, Buhrmann, and Barandiaran (2017) describe skills and habits as having an autonomous organisation in the domain of behaviour and movement. In this case, a single organisationally closed loop of skilled action might involve several component processes in coordination. The development of the skill is a process of bringing these processes into mutually supportive coordination with one another (see, for example, the discussion of a feeding infant and the processes of breathing, suckling, and swallowing, pp.84-86). In many cases of real-world activity we are likely to be able to see multiple such coordinations at any given time, where one well-organised skill, itself composed of micro-habits, connects and supports with other complex habits. While Di Paolo et al. discuss the quite encapsulated example of breastfeeding, we can look at related example of eating at

the family dinner table. In this case, implicit management of breathing and swallowing are joined by posture, and fine-control of limb movement in the use of cutlery, as well as perhaps more easily overlooked habits such as bladder control.

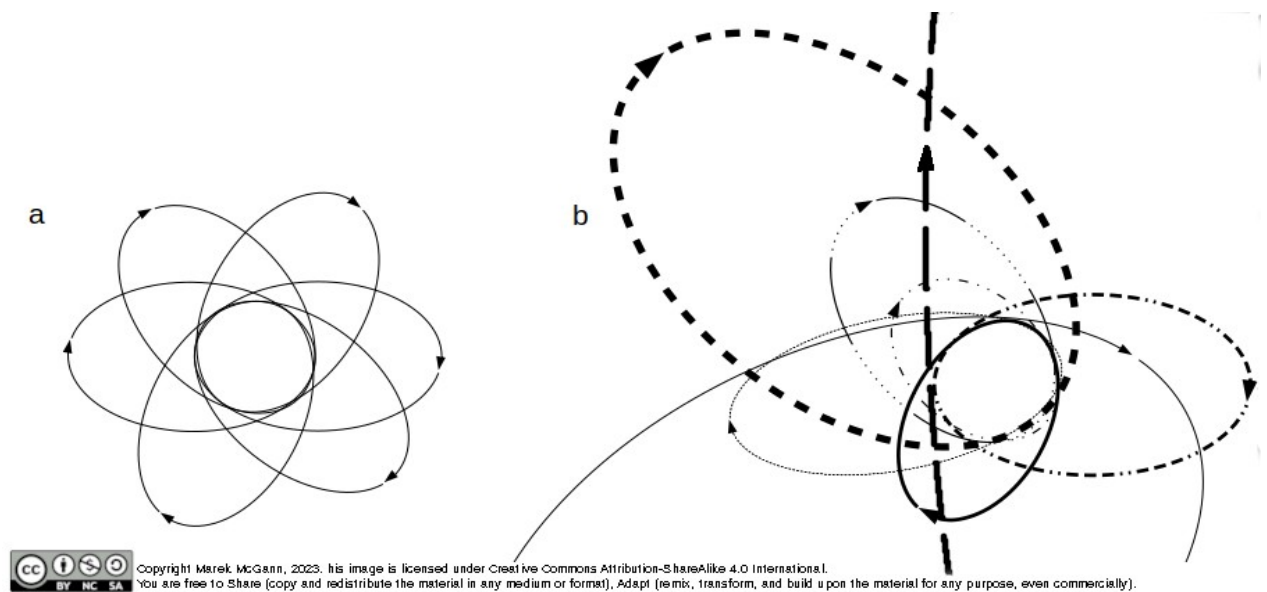


Figure 2. a) Re-schematisation of an enacted body as a multiplicity rather than unity of autonomous networks. b) Schematisation of an enactive body emphasising the diversity of temporal and physical scales of the various autonomous networks that compose it.

Just as with the dynamic of individual such networks described by Di Paolo (2018, see also 2009), these entangled networks that form the greater whole are necessarily in a relation of mutual influence. Tensions will wax and wane as the enabling conditions of these different networks come into conflict with one another over the course of development and interaction with the world. The circumstances in which the continuity can be assured is therefore a compromise, a product of their interaction rather than simple combination.

For simplicity of presentation, Figure 2a represents this tangle of systems as a collection of very similar curves, the diagram highlighting only the multiplicity. Real bodies are of course much messier. Instead of a collection of processes that are identical in tempo, spatial distribution, and complexity, the component networks of a living body are a messy knot of processes that occur at different timescales, distributed over greater and lesser volumes, involving greater or fewer number of active components, despite all still being mutually influential and affecting. Figure 2b is yet another schematisation of the enactive body, this time with this complexity in mind, illustrating not only the multiplicity, but the messiness of living bodies.

In our example of eating at the dinner table, we can add to the use of bladder control, cutlery use, and control of posture, further complexities such as the skills of polite behaviour and social interaction. Indeed, following the work of Sara Ahmed (2006), who we will discuss in more detail momentarily, this dinner table behaviour may include such deep, pervasive tides of human activity such as heteronormativity. These are behavioural and experiential phenomena that only exist in patterns bigger than individual people, though are instantiated through the ways that they orient and accent the actions of individual people. They also represent ways in which with the significant pressures of social norms and mores can suppress, and oppress, through provision or constraint of particular kinds of resources, the actions and habits of different individuals.

The enactive conception of bodies is therefore as knots of asymmetries, processes of production that occur over different temporal and spatial scales, but which ultimately result in a continuity of autonomous value over time that enables both we as observers, and the system itself, to recognise an animated perspective in the world. This is a dialectical process of distinction via engagement, with a system continuing a process of self-distinction, or individuation, in the context of being embedded in, and part of, the world around it.

Individuation, Interiority, and Orientation

Thompson (2011) describes adaptive autonomy as a process of individuation, through which the distinction of self from world is made. The precarious nature of this distinction, the fact that it must be continually enacted, creates an interiority which is necessarily normatively related to the exterior from which it is distinguished (2011, p.116; see also Thompson, 2007). But as we have noted, that interiority is necessarily formal, not material, in character. I believe that the work of Sara Ahmed (2006) provides a somewhat different perspective on the necessity of the relationship between interiority and normativity. She makes much of Derrida's recognition that experiences are not simply *present*, but *arrivant* – they arrive not just situated, but with a history, a trajectory of development. “Nothing is brought forth “without” coming to reside somewhere, where the somewhere (say, the house, the room, or the skin) shapes the surface of “what” it “is” that is brought forth.” (Ahmed, 2006, p.40).

For Ahmed, orientation is non-neutrality. It involves turning toward some things and turning away from others. As embodied, situated beings we are necessarily entangled with the world. As finite beings we cannot be entangled with all of it (at least, not all at once). The insight we can derive from Ahmed is that the maintenance of an identity is not about the policing of a membrane that divides us from the world, but about the entangling with *these* aspects of the world and not *those*. Self-distinction is achieved by a sensitivity to environmental distinctions. The ever-present example of the chemotactic microbe in enactive literature is an illustration of a process not of separation of the world into 'food' and 'not-food', but rather an illustration of an organism encountering the sugar as 'this way', orienting the well-organised cell in line with its needs, just as our vestibular organs orient our postures and actions to gravity. We become individuals, therefore, not by separation, but by differential entanglement; not by interiority but by orientation (see Cummins, 2018, for an exploration of how various aspects of intersubjectivity and individuality are managed in different domains). We transform ourselves by entangling ourselves further with some flows, which may necessitate a loosening with others – just as giving up one habit can often only be achieved by replacing it with another; transformation rather than simple subtraction of the unwanted.

While perhaps readily conceivable as relevant to identities in the social domain, we might wonder whether the same is true in the organic. Even there, in the quintessential case of self-distinction in complex animals that is the immune system, we find such dynamics in play. The tuning of the immune system early in life is a product of interaction between immune cells and local populations of microbiota (Belkaid & Hand, 2014; Olszak et al., 2012). Immune development and response is less about keeping the world out than it is about staying in with the right crowd.

The focus on orientation is only a slight change in emphasis in the description of operational closure, but it opens up a different vista from which to better understand the enactive account of living, bodies, and agency. In addition, it helps explicate some of the challenges and implications that remain to be fully grasped within that perspective. Most notably, if we understand the living body not as a separation from the flows of activity in the environment but an orientation within those flows, then the need to provide a disciplined and rich account of what is meant by 'environment', and how to provide that

account in way that adequately recognises the perspective of the agent which brings it into being, becomes very clear.

Enactive researchers have been criticised for having surprisingly little to say regarding the environment (Fultot et al., 2016; McGann, 2014), despite a core tenet of the approach being a reciprocal relationship between the cognitive agent and its world. Indeed, Di Paolo (2016 a direct response to Fultot et al.) acknowledges this limitation, though suggests it is not due to a lack of resources to address the issue, but has rather been a matter of priorities and focus. Subsequent work has certainly made some progress (e.g. Baggs & Chemero, 2020; Di Paolo et al., 2017, 2018; James, 2020; McGann, 2020; Rietveld & Kiverstein, 2014; van Dijk & Rietveld, 2017). There remains significant work to be done here. We can see clearly that while an enactive perspective provides a principled consideration of what constitutes a living system, and therefore a means of interrogating the idea of a living body in concrete terms, looking at this in ways that emphasise the world means understanding not a wholly distinct material entity, but a complex tangle of processes oriented according to the values inherent in operational closure.

The messier illustration of this conception depicted in Figure 2b helps us keep some aspects of this dynamic body in mind. In the case of the huge number of living things that are not just unities, but multiplicities, we need to recognise that bodies are not just origins of distinctions, but are places where different aspects of the world are brought into contact, and entangled with one another. Aspects of the universe that did not matter for each other prior to the living body making its way in the world are made relevant to one another in that body.

Happily, recent writing (Brancazio, 2018, 2019, 2020; Di Paolo et al., 2018; Maiese, 2021) has identified links with an extant literature on bodies and the world that offers a rich set of resources to enable us to consider this issue in some depth, if we can find the means to integrate the perspectives in question. I am thinking particularly of the past few decades of feminist philosophy, and feminist philosophy of science, where the complexity of bodies and the manner in which they weave together biological, social, and technical aspects of being, have been thematised and explored in some depth.

4 Entangling Lives: The feminist recognition of messiness

That human bodies are knotted, entangled collections of values is something that feminist authors have long recognised (e.g. Butler, 1993; Haraway, 1987; Young, 1980). As we have noted, biological autonomy does not separate the agent from its environment, but entwines it in directed ways. These themes have perhaps been explored most explicitly since Iris Marion Young's (1980) celebrated essay *Throwing Like a Girl*, and Donna Haraway's (1987) *A Manifesto for Cyborgs*. In these works these authors tease out the ways in which bodies are shaped and act within a flow of values of different kinds that originate outside of a person and continue through them. Social and technical values, demands, and activities play a role in the shaping of our bodies from the social to the cellular level and back - what foods we are exposed to, what activities we are encouraged into or banned from, what rituals, practices, and routines we propagate, all of these things shape how our bodies, habits, skills, and indeed our values, develop. Ahmed (2006) explores the ways in which social norms ensure that not only bodies, but places, things, and communities are oriented, turned toward some things and away from others, in a manner that affects the behaviour within societies in something of the same way that tides affect boats. Different bodies are incorporated into flows of social and material activity in different ways. As Ahmed (2006) notes, they arrive already oriented by the pressures of social forces and the ways in which those forces arrange and organise and deploy resources, whether material, technical, inter-personal, or otherwise.

Young (1980) critically extended Merleau-Ponty's notion of the body as the 'I can', through an explication of how social power, and not just bodily possibility, plays a role in how bodies and their various skills develop. A great many things about a person's skills are constrained by a socially enforced 'I can't'. As Ahmed (2006) has argued, to orient one way (say toward stereotypically masculine or feminine habits and skills) is to orient away from others (stereotypically, away from emotional competence or physical prowess). Human bodies are inevitably entangled in the lines of social power that they themselves instantiate, and they become distinguished from one another partly to the extent that such forces are applied differentially.

Reveling in these social and political aspects recognised by Young, Haraway (1987) explores the extent to which a body tends toward incorporation, and in doing so undermines any attempt to stipulate a determinate, fixed, or 'proper' description of bodies,

particularly in their gender, ability, and all of the related implications for diversity of experience. The body is that which incorporates, and as such is also in a constant flux. In many ways, Young, Haraway, and others, presented a very enactive view of bodies even before the term was coined (this is not terribly surprising given a certain shared genealogy, particularly in the work of Merleau-Ponty). Rather than a fixed thing, bodies are acted into being in the confluence of a diverse set of organic, social, and technical dynamics (see also Mol & Law, 2004). They are material, but material in a constant process of enactment, being brought into being and shaped by biological, social, and technical processes that precede them and will be there as any body in question dies and is transformed into unliving matter. (At which point aspects of the world, material flows, and relationships, made to matter to each other by the living body drift apart or unravel.)

On the one hand, the feminist conceptualisation of the body over the past several decades re-emphasises the mutuality of agent and environment. The quotation from Merleau-Ponty made in the very first pages of *The Embodied Mind* underpins the whole perspective: "The world is inseparable from the subject which is nothing but a project of the world, and the subject is inseparable from the world, but from a world which the subject itself projects." (Merleau-Ponty, 1962/2002, pp.499-500)

On the other hand, as we have noted, enactive researchers have not well addressed the environment, and in their accounts of autonomy and autopoiesis have tended to draw attention to the *boundary* that enacts self-individuation from the world, rather than the extent to which the agent and the world are inextricably caught up and *move through* one another. The feminist perspective thus feels at once welcome and uncomfortable for an enactive viewpoint. It brings to the fore the dialectical tension between structure and organisation. Enactivists have often kept discussions of these two aspects of the living organisation quite apart from one another, drawing a basis of value from the latter while insisting on the concrete details of the former in embodiment.

From within to along

The tendency to focus on individuation as a drawing of a boundary throws into relief the idea of the agent being embedded, or immersed, *in* its environment, but does not fully invite engagement with the agent's own perspective, and has a tendency to keep the focus just a little more narrowly on the agent rather than the encounter with and interaction

with the world (despite slogans to the contrary). The feminist perspective of entanglement and orientation helps us to realise that what makes agency is not just the embedding of the agent in the world, but the manner in which the agent *moves with and through*, the world. Formally an autonomous living system is individuated and distinct, but structurally, materially, the distinction is not a momentary or instantaneous thing, but a trajectory. Autonomy is an *animating dynamic*, one that transforms a world from a meaningless mass to a oriented, meaningful set of processes that we call living, and making sense. The asymmetry created by such a dynamic is not so much one that separates an interior from and exterior, but a before from after, this way from that way. The agent is not something that is defined by what is within, but by what is *along* (Ingold, 2007). There is no sharp division between the material agent and its environment, but there is a process of animation which is continuous and meaningful and which we can identify as present or absent, more or less precarious.

Interestingly, what this means is that autonomy does not just assign agency to an individuated or denominated system we call an agent, but rather *animates the world in particular ways* (we will see in the next section how the work of Karen Barad provides a framework for thinking about this). We have already noted that real bodies tend to be complexes or multiplicities. That being the case, we can note that real agents tend to be multiply animated, and adaptivity is less an achievement of a single individual than it is a certain kind of dynamic meta-stability achieved in the interaction between multiply animated, multiply oriented systems.

I should note that this is entirely in keeping with some of what have become the core tenets of the enactive approach when discussed in terms of the life-mind continuity thesis, though perhaps not unpacked explicitly in depth.. Weber & Varela (2002) first made connections with the existential phenomenology of Hans Jonas (1966), which has been enthusiastically adopted by others since (e.g. Di Paolo, 2005; Thompson, 2007; Torrance, 2016). Jonas oriented his recognition of life on that of metabolism, the manner in which a biological system transforms and is simultaneously transformed by the processes that connect it with its environment (that we often itemise as processes such as feeding, digestion, growth, excretion, and so on). Nonetheless, the implications of the concrete materiality of embodiment for our understanding of the relationship between autonomy,

life, and the environment are now seeing richer discussion (see particularly Di Paolo, Cuffari, & De Jaegher 2018).

As we move our emphasis from the idea of embodiment embedding the agent in the world to one which sees bodies and life as moving through the world in particular ways, aspects of sense-making that have heretofore been relatively obscure move closer to centre stage.

Cycles, Dimensions, of Embodiment

Originally adumbrated in Thompson and Varela (2001), enactive researchers occasionally distinguish different aspects of embodied being (Thompson and Varela describe them as 'cycles of operation' [p.424], Di Paolo, Buhrmann, & Barandiaran, 2017, call them 'dimensions of embodiment'). These are the organic, the sensorimotor, and the intersubjective, and provide the basis within an enactive approach for theorising the ways in which different domains of activity intersect and affect one another, constituting the life of the agent:

Three kinds of cycles need to be distinguished for higher primates:

- (1) cycles of organismic regulation of the entire body;
- (2) cycles of sensorimotor coupling between organism and environment;
- (3) cycles of intersubjective interaction, involving the recognition of the intentional meaning of actions and linguistic communication (in humans)

(Thompson & Varela, 2001, p.424)

In *Linguistic Bodies*, Di Paolo, Cuffari, and De Jaegher (2018) point out that while these three dimensions of embodiment can be distinguished from each other, they are not independent of each other. Indeed, there are feedback relations between them that ensure that while we can recognise autonomous dynamics in one dimension, those dynamics both constrain and are constrained by the dynamics in other dimensions.

For instance, organic embodiment brings with it the constant needfulness of metabolism - breath, hunger, thirst, the demands of biological maintenance. The habits that arise in the domain of behaviour (what is termed the 'sensorimotor' dimension) are clearly both driven (though not wholly determined) by, and also constrained by, the organic aspects of our being. But the organic is similarly affected by the behaviour. Egbert & Cañamero (2014),

for instance, demonstrate how behavioural activity can play a central role in the maintenance of a core organic need - in this case the regulation of glucose levels within the blood. More prosaically, we can consider the various ways in which our bodies change in response to different habits of eating and exercise. The relationship between the organic and sensorimotor domains is therefore not simply one of either independence nor reduction, but one of mutual interplay despite their distinctiveness (Mol & Law, 2004).

Similarly, the intersubjective domain, in which we find language, society, and culture, is affected by and also feeds back on the organic and sensorimotor, doing so at a number of different timescales. Keeping close to our previous example, transformations of diet and behavioural activity as a result of cultural practices and norms over the past few decades have induced changes in organic bodies that too, have come to affect blood glucose levels - in this instance, in the form of both increasing and decreasing prevalence of Type II diabetes (Magliano et al., 2019).

Feminist work has tended to a stark recognition of this multiply entangled aspect of bodily being, and have for decades teased out its various threads and explored some of its implications. The mutuality of influence is one of the most important that we will need to address. For those of us raised within the Western scientific tradition the temptation is always to build large things from small things - to find basic building blocks and examine the ways in which they are put together. But to understand individual agency, we must also understand the tidal flows and currents of activity in which the vortices of human agency arise. Haraway, Butler, Young, Ahmed and others make very clear that we must resist any notion of agency emanating solely *ex individuo*, thrust outward into the world as though the world did not exist, imposed no pressures, made no demands, before the coming into being of the powerful individual in which we might be interested.

While operational closure helps us understand the dynamics of agency, the re-enchantment of the material which is moving through the enactive literature in recent years makes it clear that even adaptive forms of such closure, creating a unity, is one aspect of agency, rather than its comprehensive statement. It is a body's nature to join things together, to entangle things. Through bodies, processes of the world that had nothing to do with one another are brought into meaningful, impactful, contact. They make things matter. From such a viewpoint, what is a body in the enactive approach? It is a means by which things are joined together and oriented meaningfully.

We thus reach the question of whether this literature presents a view of the interaction between an agent and its world in a way that meshes with both that of the feminist literature, with its recognition of the messy tangle of bodily being, and the enactive approach, resistant to the notion of a determinate or pre-given world. As it happens, one such framework has been broached in some detail, via Karen Barad.

5 Real, Enacted Bodies, in a Real, Enacted World

In their magisterial *Meeting the Universe Halfway*, Karen Barad (2007) introduces an ontological view they term "agential realism". This is a view that challenges the traditional dichotomy between the subjective and the objective, much as does the enactive approach. Barad at once argues that the agency of the observer perceiving the world matters to the world that is perceived, but recognises that this does not lead us into an "anything goes" relativism - indeterminacy does not imply nihilism. The agent is in the world, not separate to it, and so the world gets a say in any agency that we might want to invoke.

Crucial to this approach is a recognition that no single canonical account of the universe is possible. Barad extensively elaborates the philosophical and physical work of Niels Bohr to argue that there is no exhaustive story that can be told of a determinate universe. There is always, necessarily and unavoidably, agency involved in any scientific account. Barad is at pains to note that the involvement of agency in the description of the universe is not simply a practical matter - something that is unavoidable in real terms but unnecessary in principle. Rather, in a universe that is fundamentally indeterminate, the *only* way in which specific observations or determinate statements can be made is to recognise the essential role for agency. As Maturana famously noted, every observation is made by an observer, everything said is said by someone (Maturana & Varela, 1987, p.27; Maturana, 1980). Barad makes explicit the reciprocal relationship that is also at the heart of the enactive approach - every observer exists in (and is composed from) the world it observes. Any observation, or statement about the world, requires the specification of an agent making the observation. Barad calls this making an *agential cut*, as the observation necessarily involves a distinction being made between the agent making the observation and the world it is observing. Precisely how the agent is defined therefore plays a significant role in the production of the observation.

But agents are not simple things. Rather, they are themselves complexes of processes. In the case of a human being making a scientific observation, for instance, we are talking about a host of biological, social, and technical processes that compose the skilled practitioner of a professional discipline making use of a piece of technical apparatus. The various aspects of this complex - the individual biological matters, the professional standards of practice and routines, the material artefacts and their configurations - are products of historical flows of activity across several domains, and spatial and temporal scales (indeed, Barad notes that spatiality and temporality themselves emerge through these processes, though this is beyond the scope of our present discussion).

To flag this inextricability of the agent from the universe, Barad introduces the term "intra-action". They note that what is at play here is not a distinct entity *interacting* with its separate environment, but a universe in the throes of particular kinds of transformation, some of which come to matter in different ways because of the bodies and agencies that are caught up in those transformations.

Enactive researchers have grounded their view in an identification of how something can come to matter, which is to recognise the potency of an autonomous organisation of processes, by which a system can come to distinguish itself, such that its various transformations over time are meaningful to it. The enactive approach thus makes a clear statement about what kinds of intra-actions (flows of activity within the world), should count as valid points for such an agential cut. Barad's argument resists a careless and anything goes relativism, the enactive approach includes a set of principles by which the approach understands the set of constraints that therefore apply.

Barad's account (which integrates and "diffracts" Bohr, along with other thinkers such as Young, Haraway, and Butler), recognises that any such cut is one of many possible ones that could be made, and that agency is generally complex rather than unitary. What is more, involved in making that cut are the technical aspects of the apparatus involved in the observation in question, but also the host of social privileges and pressures in which the observation is taking place (for instance, who gets to make such observations is a careful controlled social process). Adopting Barad's perspective, the genealogy of their work makes available to us a host of new theoretical resources with which we can interrogate the complexity of agency with which we must contend.

No Canonical Body, And That's Okay

From the messiness of bodies we can see that some forms of adaptivity may derive from the diversity of values that are entangled with one another in a given system. The unity of the system plays an important role in grounding or naturalising value, which is deemed vital to the enactive perspective, and a significant part of the approach's positive contribution to cognitive science - the prospect of a science of meaning. This emphasis on a *unity*, however, is one that is challenged by the messiness of bodies (see also Cummins & De Jesus, 2016, on the necessarily isolated character of bodies in such descriptions).

Varela (1997) raised the question of multiplicity and what he termed the "closure galaxy" - how identities in different domains interact with one another. Given the multiplicity of this meshwork, how then should we consider embodiment and agency, if these things are typically addressed as being grounded in the maintenance or conservation of a unity? If there is no canonical account of any given body, how can a body be such a ground?

The enactive approach famously undermines the very idea of a solid, stable ground for our understanding of cognition and agency. Varela, Thompson, & Rosch (1991) repeatedly remark that any attempt to define a stable ground from which to build is a effort doomed to failure; the reflexivity of the cognitive scientific endeavour ensures that we will only ever find ourselves standing on shifting sands. The work of feminist theorists helps us realise that an enactive approach does not offer grounding, but rather orientation, and the richness of our sensitivities to the world provides ever more specific and particular orientations.

6 Concluding remarks

I have argued in this paper that it is important to recognise not just the unity, but the orientation, the directedness, that arises in the interplay between operational closure and structure; an asymmetry of trajectory rather than interiority. Living bodies made of tangles of several such orientings are bodies that are multiply animated, and therefore also multiply sensitive to the world, enacting complex environments, making things matter, making meaning. These entanglements can happen within a given dimension of embodiment (organic, sensorimotor, intersubjective) and across them.

There are a few outcomes that we can take from this recognition. The first, in keeping with enactive thinking, even in relatively simple cases there will never be a single ground or value shaping an agent's behaviour. Understanding intentions will require the kind diachronic, hermenutic approach described by Alica Juarrero (2002). Though Juarrero's philosophy of action is grounded in a form of connectionist representation that is inconsistent with the enactive approach I have taken here, the dynamism and context-involving character of intentional action that she elucidates is entirely in keeping, and the implications that she derives apply. Just as we have learned from Barad, and indeed a great many other scholars of Science and Technology Studies, as well as Haraway and other feminist thinkers, understanding of agency and action is a matter not of pinning down what an agent intends, but a matter of being able to move along with them over time.

As we have already noted also, there is work to be done to continue to explicate the enactive environment, though we can here take heart that researchers in these related fields have produced a rich body of work with which enactive thinking is resonant, and with which we may see significant alignment and productive collaboration in the future.

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