*Commentary*

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# Normativity: A Crucial Kind of Emergence

## Commentary on Witherington

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Witherington [this issue] argues that the antistructuralist stance of certain dynamic systems (DS) approaches undermines the essential role of emergence for understanding mental phenomena. If structure is intended to include representation, then we agree. We offer a model of representation that is ultimately grounded in the emergence of normativity in systems that are far from thermodynamic equilibrium (FFE). A cascade of further emergences provides the essential elements for a fully naturalized account of representation, learning, and development.

The DS approach to the study of human development involves a fundamental commitment to the process of 'emergence through self-organization.' Witherington [2007, this issue] argues for a rift *within* DS approaches with respect to the causal status of emergent structure and the legitimacy of formal and final explanations. He argues that the type of DS approach advocated by Thelen and Smith [1994] relies too heavily on the self-organizational principle of 'global order out of local interactions' and neglects the efficacy of those 'global order' structures per se. For these researchers, the fact that order (structure) can arise without prescription or plan was the key for rejecting developmental approaches in which the end state (the structure) was presupposed by the process of development itself. Witherington's main thesis is that the antistructuralism of the Thelen-and-Smith brand of DS 'threatens to undermine the explanatory significance of DS's most foundational, unifying principle: emergence through self-organization' [this issue]. If Witherington's 'structure' is intended to include representation, then we agree that DS approaches that ignore or deny the efficacy of emergent organization are incomplete as a meta-theoretical framework for the developmental sciences.

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The dynamicists' concern with models that presuppose what is supposed to be explained can also be seen to apply to standard notions of representation – representations as encodings. The representational content of an encoding is necessarily derivative [Bickhard & Terveen, 1995]. That is, in order to represent anything at all, encoded symbols must borrow their content from some other source. If that other source must itself be an encoded symbol, then there is no way to account for the emergence of representational content. Therefore, an encoded symbol notion of representation must presuppose its own content in order to represent anything at all, but such representational capacity is what was supposed to be explained.

Conceptual difficulties for encoded symbol notions of representation were central to both connectionist and dynamicist revolutions in cognitive science [Clark, 2001]. Further, it was these difficulties that contributed to the broader antirepresentationalism that was present during the 90s for both DS and robotics [Brooks, 1991; Port & Van Gelder, 1995; Thelen & Smith, 1994]. However, rather than reject representation altogether, we propose an alternative notion of representation that is grounded in the more general emergence of normative phenomena (i.e., normative function).

## Normative Emergence

Witherington [this issue] highlights the distinction between 'epistemological' and 'ontological' emergence[1] – the relevant difference being that the former commits to an epiphenomenalism at the level of emergent organization while the latter accepts the causal efficacy of such organization in terms of downward causation. That is, for the ontological emergentist only, emergent global order causally influences the constituent local interactions that gave rise to that order through downward causation. In turn, downward causation is to be understood in terms of formal and final causes. We agree that emergent organization is not epiphenomenal – it is the metaphysical nature of all reality, and, to the extent that anything like cause is metaphysically real, it is as properties of process organization. However, we are concerned that a commitment to Aristotle's four causes forces a commitment to epistemological emergence – the four 'causes' are epistemological forms of explanation. Even efficient cause is, for Aristotle, paradigmatically a man building a house. Furthermore, qua forms of explanation, the four causes are not exhaustive – e.g., dispositional, boundary conditions, variation and selection, emergence, etc. [Bickhard & Campbell, 2003].

Witherington [this issue] attributes the failure of the Thelen-and-Smith type DS to consider downward causation to their failure to distinguish between two fundamentally different types of self-organizing systems: physicochemical dissipative systems and autonomous, or autopoietic[2], open systems (nonliving vs. living sys-

[1] The British Emergentists' commitment to the nonderivability of emergent properties from their emergence base is, we claim, metaphysically unwise, and is not necessary for emergence to be nonepiphenomenal.

[2] With its focus on autonomy as self-creation and independence from environment, autopoiesis cannot handle development [Moreno, Etxeberria, & Umerez, 2008] nor does it provide an adequate framework for relationships between system and environment, such as cognition and representation [Bickhard, in preparation].

tems). Witherington points out that living systems 'construct themselves by generating the very boundary conditions necessary for creation and maintenance of their *self*-organization.' It is the 'creation' and 'maintenance' aspects of this type of self-organizing system that constitutes the crucial emergence found only in living systems: the emergence of agency.

However, the class of open systems that contribute to their own maintenance is broader than the class of living systems. For example, the candle flame:

> A candle flame maintains above combustion threshold temperature, induces convection, which brings in oxygen and gets rid of waste, vaporizes wax in the wick for combustion and melts wax in the candle so that it can percolate up the wick. [Bickhard, 2009a, p. 554]

The point here is that the *initial* fundamental distinction that needs to be drawn is not between living and nonliving systems, but rather between systems that are far from thermodynamic equilibrium (FFE) and those that are energy well stable [Bickhard, 2009a]. The condition of being FFE requires a continuous flow of energy coming into the system or else it will go to equilibrium and cease to exist. In contrast, energy well stabilities can exist at equilibrium for cosmological time (e.g., a rock or an atom). The crucial emergence born of this fundamental distinction is normative emergence: FFE systems are dependent on being maintained in their FFE condition (they cannot be isolated from their environments without going to equilibrium). Such maintenance is functional for the continued existence (stability) of the system. Multiple further normative emergences – e.g., cognition and representation – occur within this basic framework.

While the maintenance of a system may be accomplished by sources that are external to it (e.g., the chemical vat), some other systems contribute to their own maintenance – self-maintenant systems [Bickhard, 1993, 2009a]. Self-maintenant systems may differ from dissipative systems in the sense outlined by Witherington [this issue] but they are not necessarily agentive (i.e., the candle flame), and crucially, they *are* normative. A system that contributes to its own maintenance has a normative stake in its own existence. Further, those contributions will be functional relative to the stability of the system being maintained. That is, normative function is emergent from FFE systems because they require maintenance in order to persist.

## Representational Emergence: Increases in Organizational and Normative Complexity

### *Recursively Self-Maintenant Systems*

The self-maintenance of a candle flame is limited by its capacity to do only one thing – burn. If environmental conditions move outside some fairly narrow range of conditions, then the flame will go out and cease to exist. However, more complex systems have a capacity to maintain the property of being self-maintenant in that they can select amongst different types of activity that will be appropriate to changing conditions in the environment. These more complex systems are *recursively* self-maintenant [Bickhard, 1993, 2009a]. They are systems that can vary *how* they contribute to their condition of being self-maintenant – they are systems that maintain their self-maintenance. It is from recursively self-maintenant systems that we get the relevant normativity for how to model a dynamic notion of representation[3].

*The Bacterium: Normative Function.* A canonical example of a recursively self-maintenant system is Don Campbell's bacterium [Bickhard, 2009b; Campbell, 1974, 1990]. The bacterium contributes to its self-maintenance by swimming when oriented up a sugar gradient and by tumbling when oriented down a sugar gradient. These activities can be considered *appropriate* because they serve the *function* of maintaining the FFE stability that constitutes the bacterium. Selection between these activities is based on a triggering relationship between the detection of appropriate environmental conditions and action.

*The Frog: Normative Success and Failure.* In more sophisticated organisms, like the frog, the relationship between the detection of appropriate environmental conditions and action will be more complex. There will typically be multiple potential interactions that are indicated as available to a frog and it must select amongst those possibilities. For example, in a given situation, a frog might have an opportunity to flick its tongue and eat a fly or a worm, or to hop in the water to avoid a predator overhead [Bickhard, 1993, 2009b, 2009c]. A triggering relationship will not suffice for this type of organism because a single environment has multiple relevant possibilities.

Importantly, the possibilities indicated for the frog will implicitly predicate that the current environment is functionally appropriate to those possibilities, and those assumed or predicated environmental properties can *hold* or *not hold* – that is, the assumption or predication is *about* the environment and can be *true* or *false*. If the frog proceeds to engage in one of the indicated possible interactions, then it has the potential to *succeed* or to *fail*: if the environmental conditions are appropriate to the indicated possibility, then the interaction will succeed, if not, then the interaction will fail. Notice also that the success and failure are with respect to the functionally indicated possibility and therefore are functionally available to the organism as feedback. In contrast, the truth and falsity are with respect to the implicit predication and are therefore about the environment[4].

*Summary.* The maintenance aspect of FFE systems enables the emergence of normative function and therefore the appropriateness of action in an environment. In turn, function and appropriateness enable the further emergence of normative success and failure. Finally, the implicit predication *about* the environment and upon which the success or failure of an interaction is based yields a normative notion of truth and falsity that enables a fully dynamical model of representation.

[3] Recursively self-maintenant systems that can reproduce [Griesemer, 2000a, 2000b] are good candidates for living systems. For discussions of agency within this general framework, see for example Campbell [2009] and Hooker [2009].

[4] The interactive model of representation is the only model in the literature that addresses the possibility of organism-detectable error [Bickhard, 2009b], and, therefore, that can model error-guided behavior and learning.

*Object Representation*

Our discussion of frogs has demonstrated the emergence of two fundamental properties of representation: *aboutness* and *truth value*. However, functional indications regarding the interactive possibilities for frogs flicking their tongue and eating seem quite distant from something more canonical like object representation.

We briefly outline a model of object representation, one that borrows heavily from Piaget's model of object representation [Piaget, 1954][5]. Specifically, the representing of objects is constituted by a web of interactive possibilities (the object's affordances) in which each of these possible interactions will be reachable from any other (e.g., a visual scan of the back side of a block is reachable by turning the block over, etc.). Further, this web of mutually reachable indications will remain constant with respect to a large class of other activities (e.g., if the block is dropped or put away in another room, the interactive possibilities can be recovered through appropriate intermediate activities); however, not all interactions or changes will preserve the block's collection of interactive possibilities (e.g., if the block is burned or pulverized). In short, the representing of objects is constituted by a mutually reachable invariant (sub-)web of interactive possibilities.

*(Inter)action as the Proper Locus for Understanding Cognition*

Only an action-based approach to mental phenomena has been able to account for the emergence of representation out of a foundation that is not itself already representational [i.e., representation is emergent in the functional organization of (inter)action systems]. Within developmental psychology, the need to assume a representation base in order to account for the development of knowledge is at the core of an intractable debate between nativism and empiricism [Allen & Bickhard, in press b]. The antirepresentationalism of the DS approach is itself a reaction to the failure of the nativist-empiricist debate to adequately resolve the question of the origins of knowledge; all parties, however, have accepted a false encoding notion of representation as their starting point and then reacted to the issues from within that framework[6], and, therefore, all parties have been pursuing an ill-formed issue. All parties have failed to address the dynamic emergence of representation.

## Learning and Development

The transition to an action basis removes any temptation to think that representation could be impressed into a passive mind, for example, via transduction or induction. Knowledge and representation are constituted in competent interaction

[5] This borrowing is possible because of a shared pragmatist commitment to action as the proper framework for modeling mental phenomena.

[6] Notice that Fodor's [1975] argument for nativism turns on the inability for encoding notions of representation to account for their own content. However, as Fodor [Chomsky & Fodor, 1980] himself has commented, his nativist conclusion is probably a reduction for some of our assumptions about the nature of representation and learning.

systems, and such systems must be actively constructed: learning about the world means learning how to successfully interact with it. Therefore, knowledge, as interactive competence, must be a constructivist process, and, without prescience, it must be a *variation* and *selection* constructivist process – an evolutionary epistemology [Campbell, 1974]. The emergence of representation out of action, then, forces a variation and selection *emergent constructivism* as the basis for learning [Allen & Bickhard, in press a; Bickhard, 2006].

General categories of properties of and constraints on learning derive from the fact that constructive learning processes depend on both past (recursive) as well as current contexts (i.e., learning processes will have historistic properties). Emergent constructivism involves the possibility of *recursive* learning in at least two senses: first, previous constructions can be reused in future constructions (but without any restriction to a fixed set of innate representational atoms); second, new constructions can emerge from variations on and within previous constructions [Campbell & Bickhard, 1991]. Further, emergent constructivist models of learning also enable the possibility of *meta-recursive* constructive processes in which the constructive processes themselves undergo learning (i.e., learning to learn) [Bickhard, 2006]. In turn, development is constituted by the long-term constraints and historicities of the constructivist learning processes. In this perspective, there is only one underlying dynamic process; however, it can be studied at short time scales (learning) or long time scales (development).

## Conclusion

We agree with many of the positions and claims argued for by Witherington [this issue]. The possibility of ontological emergence needs to be a crucial theoretical constraint on any adequate approach to the developmental sciences. In turn, the centrality of emergence requires the adoption of a metaphysical framework where process organization forms the proper locus for studying FFE systems. That said, we have tried to present a case that normativity constitutes a crucial kind of emergence that has cascading implications for understanding all mental phenomena, including representation, learning, and development.

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