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Information, Representation, Biology

Mark H. Bickhard [1]

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Abstract Biosemiotics contains at its core fundamental issues of naturalism: are normative properties, such as meaning, referent, and others, part of the natural world, or are they part of a second, intentional and normative, metaphysical realm — one that might be analogically applied to natural phenomena, such as within biological cells — but a realm that nevertheless remains metaphysically distinct? Such issues are manifestations of a fundamental metaphysical split between a "natural" realm and a realm of normativity and intentionality. This problematic metaphysical split derives from conceptual problems originating with the Pre-Socratics; transcending that split requires correcting those problems. In particular, transcending that split requires a model of metaphysical emergence, and, in particular, normative emergence. This paper will limn that argument regarding metaphysical emergence, but focus most strongly on an overview of a model of normative, representational emergence that overcomes that metaphysical diremption.

Keywords Representation · Interactivism · Transduction · Emergence · Scaffolding · Process

Biosemiotics contains at its core fundamental issues of naturalism: are normative properties, such as meaning, referent, and others, part of the natural world, or are they part of a second, intentional and normative, metaphysical realm — one that might be analogically *applied* to natural phenomena, such as within biological cells — but a realm that nevertheless remains metaphysically distinct?[1]

[1]Some would disagree with this division — either with its exhaustiveness or relevance. For a metaphysical naturalist, however, the issue seems clearly posed: phenomena are either chartacteristics of the 'natural' world, or not. Further, positions that hold that e.g., meaning and reference are not normative at all, are free to use terms as they please, but, if there is any possibility of error involved here, then normativity seems clearly to be involved. And, if there is no possibility of error, then such characterizations are seriously problematic. This is not the place to investigate such stances further.

✉ Mark H. Bickhard
mhb0@lehigh.edu; http://bickhard.ws

1 Lehigh University, Bethlehem, PA 18015, USA

There are multiple terms at the basis of biosemiotics that are ambiguous — and, thus, potentially equivocal — between natural understandings and normative understandings. Is information a strictly natural property, such as correlation, or is it semantic and meaningful? Is being a referent a strictly natural relationship, such as being correlated with, or is it a representational phenomenon realized in or by an epistemic, thus normative, interpretive agent? Does a sign stand for, or stand in for, a signified in a factual or (also) a representational (normative) sense?

At times biosemiotics discussions proceed in terms of analogies with language, at other times, in terms of something stronger than analogy, and at times with language in the background, not explicitly discussed (Hoffmeyer and Emmeche 1991; Pattee 2013). Such analogies can be useful, but, in this case, the analogies are with language as an *encoding system*, and that model of language is itself, arguably, false, and even incoherent (Bickhard 2009).[2] In fact, I argue that the model of language as an encoding system commits the same begging the question equivocation that it is deployed to dissolve. Analogies with a false analogical base risk give rise to incorrect "insights".

These issues are manifestations of a fundamental metaphysical split between a "natural" realm and a realm of normativity and intentionality. This problematic metaphysical split derives from conceptual problems originating with the Pre-Socratics; transcending that split requires correcting those problems. In particular, transcending that split requires a model of metaphysical emergence, and, in particular, normative emergence (Bickhard 2009). This paper will limn that argument regarding metaphysical emergence, but focus most strongly on an overview of a model of normative, representational emergence that overcomes that metaphysical diremption.

Substance/Particle Metaphysics and Emergence

I begin with Heraclitus, who famously (or infamously) argued that all is flow, all is process. In contradiction to this, Parmenides claimed that change is not possible[3]: The Parmenidean argument has had enormous influence over the course of Western history. The basic point is that, in order for change to occur, say from A to B, A would have to disappear into nothingness and B would have to emerge out of nothingness. Nothingness doesn't exist, so no such change is possible.

This argument sounds odd to contemporary ears, but it is better understood if it is recognized that Parmenides was addressing A and B as whatever constitutes the *most fundamental* level of reality. At such a basic level, there is nothing for A to "dissolve" into nor for B to emerge from.

Parmenides certainly knew that the world *appears* to involve change, but his writings on that topic have been lost. Empedocles and Democritus, however, provided metaphysics that attempted to account for change — or at least the appearance of

[2] A reviewer has made the claim that biosemiotics has moved beyond language analogies. I appreciate that, though my familiarity with that literature is far from complete. I would ask, however, if those movements into more semiotic frameworks succeed in avoiding the encodingism assumptions of the basic language framework?

[3] It is contentious whether or not Parmenides was directing his arguments to Heraclitus, or whether he had even heard of him (Graham 1997, 2006; Palmer 2010). Regardless, Parmenides' arguments directly counter those of Heraclitus.

change — while nevertheless honoring the Parmenidean proscription against fundamental change. For Empedocles, four basic substances — earth, air, fire, and water — did not change, but varying mixtures of them could change into other mixtures. ‘Superficial’ change, thus, was in terms of mixtures of substances that remained unchanging as substrates for change. For Democritus, those unchanging substrates were constituted as indivisible atoms, whose configurations could change, but not the fundamental atoms themselves.

This assumption of a necessary unchanging substrate for change was maintained by Aristotle (Gill 1989), though in a much more sophisticated metaphysics, and it is from Aristotle that the assumption has descended for millennia since. The contemporary version of this assumption is in terms of basic particles that (re-)configure, but remain themselves unchanged.[4]

An assumption of these attempts to characterize the natural world is that that world is constituted as basic substances (or particles) and their factual and causal relationships. Crucially, the natural world *thus characterized* does not contain properties of normativity or intentionality. There is a metaphysical split induced by such frameworks.

Given such a split, there are only three general possibilities:

- A dual metaphysics encompassing both sides of the split, such as Aristotle’s matter and form — or Descartes’ dual substances, or contemporary property dualisms;
- A metaphysics that attempts to account for everything in terms of the normative/intentional realm — some form of idealism, such as that of Hegel, Green, or Bradley;
- A metaphysics that attempts to account for everything in terms of the ‘natural’ substance or particle based realm.

This latter ‘naturalism’ dominates contemporary thought, and grounds the attempts to model normative/intentional phenomena in naturalistic ways.

If the normative realm and the physical realm could be related via emergence, the split could be overcome. But the Parmenidean argument was expressly designed to preclude emergence, and it has done so very effectively. I will not address the multiple contemporary arguments against emergence here (see, e.g., Kim 1993), but I do note that they are all based on substance and particle metaphysical assumptions, and they fail if those are given up.

The core of emergence is that organization, including new organization, yields new properties — metaphysically real and sometimes important properties. In a particle based framework, organization is ‘just’ particle configuration, and configuration is just the stage setting for particles to engage in their causal interactions. Differing configurations can yield differing outcomes or regularities, but there is no new or emergent causal power (Kim 1991).

In a process metaphysics, however, processes have whatever influences on the world that they might have in necessary part in virtue of their organization. Organization has ‘causal’ power, and it cannot be delegitimated as a locus of potential causal power without eliminating causality from the universe. Process, in other words, makes

[4] Note that this assumption is contradicted by contemporary physics, a point that I will return to below.

organization a potential locus for emergent (causal) properties (Bickhard 2009, 2015d; Campbell 2015; Seibt 2000a, 2000b, 2001, 2003, 2009).

The slogan version of this point is "Back to Heraclitus". Process enables emergence, and, potentially, the emergence of normative and intentional phenomena. Undoing the Parmenidean rejection of process, and thereby undoing his proscription against change, opens the possibility of transcending the split via emergence.

Why Process?

A process metaphysics rescues emergence, but are there other reasons for adopting such a metaphysics? There are a number. Here are two: a world of point particles, and nothing else, would be a world in which nothing ever happens: point particles have zero probability of ever encountering each other, and there would be no possibility of their being attracted to or repulsed by each other. A world of point particles interacting via fields, a common contemporary view, is contradicted by contemporary physics, but, nevertheless, it already enables emergence: fields are organized processes.

The second reason is that contemporary physics holds that there are no particles (e.g., Aitchison 1985; Bickhard 2009; Davies 1984; Fraser 2008; Halvorson and Clifton 2002; Huggett 2000; Hobson 2013; Kuhlmann et al. 2002; Sciama 1991; Weinberg 1977, 1995). What remains of particle talk is quantized interactions among excitations of quantum fields, but these quantizations are equivalent to the wavelength quantizations of a guitar string. There are no guitar sound particles. QFT excitations are wave-like processes, not particles.

Again, back to Heraclitus. With emergence a metaphysically viable possibility, we are now in a position to consider *normative* emergence.

The Emergence of Representational Normativity

For a substance or particle metaphysics, *no change* is the metaphysical default: any *appearance* of change requires further explanation. For a process metaphysics, this default is inverted: *change* is the default and any sort of stability or persistence requires explanation.

It is organizations of process that can manifest stability: The processes per se are always ongoing. One form of relatively stable process organization is one in which the organization is in a local energy well — in which the organization will persist unless some above threshold energy impinges on the process. An atom is a canonical example: it can remain stable for cosmological time periods.

Self-Maintenance and Recursive Self-Maintenance

A crucial characteristic of energy-well stabilities is that, if isolated and allowed to go to thermodynamic equilibrium, they remain persistent. A different kind of stable organization inverts this. Processes organizations that are ontologically far from thermodynamic equilibrium must be *maintained* in their far from equilibrium conditions. If they are not so maintained, they go to equilibrium and cease to exist. Atoms do *not* require such maintenance.

A vat with various chemicals pumped in, perhaps for the sake of the self-organization that will emerge, is an example of a far from equilibrium process. It is maintained by those pumps.

Some far from equilibrium processes, however, make their own contributions to the maintenance of their far from equilibrium conditions: they are *self-maintaining*. A canonical example is a candle flame. The candle flame maintains above combustion threshold temperature, vaporizes wax in the wick, melts wax in the candle so that it can percolate up the wick, induces convection which brings in oxygen and removes waste products, and so on. A candle flame is *constituted* as such a self-maintaining process.

If a candle flame is running out of wax, it has no alternatives that it can engage in to keep itself going in the face of that threat to its persistence. Some processes, however, do have such alternatives. Campbell's bacterium, for example, can swim, and, if it is swimming up a sugar gradient, it will tend to keep swimming, while, if it is swimming down a sugar gradient, it will tend to tumble and then resume swimming (Campbell 1974, 1990).[5] Swimming contributes to self-maintenance if oriented up a sugar gradient, but tumbling contributes to self-maintenance if oriented down such a gradient: swimming *down* a sugar gradient is detrimental to the persistence of the bacterium. In this manner, the bacterium can self-maintain its property of being self-maintenant: it is *recursively* self-maintenant (Bickhard 2009).[6]

Normative Function

Contributions to the maintenance of a far from equilibrium process are *functional for*, and *relative to*, that persistence. This is a model of normative function: something can be dysfunctional as well as functional — e.g., the bacterium swimming up a saccharin gradient is dysfunctional for that bacterium.[7] The sense in which this is a relative sense of function is illustrated by the heart beat of a parasite, which is functional for the parasite, but dysfunctional for the host.

This model contrasts with etiological models of function (e.g., Millikan 1984, 1993, 2004) in several ways. One is that it focuses on *serving* a function — being functional for — rather than *having* a function (though it also offers a model of having a function).[8]

A focus on serving functions makes it relatively easy to account for cases in which functions are served in new ways, such as leg muscles serving the function of aiding blood circulation on long plane flights — or functions being served by artifacts. There is also a natural manner of modeling functionality that is distributed across parts or domains of an organism, or a given organ that serves multiple functions. All of these pose at least difficulties for etiological models.

For current purposes, the crucial point is that normative function is the basic form of normative emergence out of which other forms of normativity are themselves emergent, including, in particular, representation.

[5] Campbell discussed a paramecium in his 1974, but switched to a bacterium in 1990. Both models were simplified from real single cells, but they nevertheless illustrate the point well enough.

[6] Note that *all* living systems are far from equilibrium self-maintaining systems, including viruses in active phases of their processes. This is the proper metaphysical realm for approaching biological phenomena.

[7] Or at least for most bacteria.

[8] I argue that etiological models have major problems (Bickhard 2009; Christensen and Bickhard 2002).

Representationality

Representationality normativity —processes that involve truth value, that involve being true or false [9] — emerges in processes that serve a particular kind of function, the function of action selection.

Consider a complex agent, perhaps a frog. In order to select what to do next, it has to have some sort of indications of what it *could* do next. It is not functional to flick its tongue in a direction in which there is no fly or worm. The frog, then, must have some processes that serve that function of indicating interaction possibilities. Perhaps a fly here, another fly over there, and a worm down and straight ahead. The selection process is itself potentially complex and is of fundamental importance (Bickhard 2000, 2003), but the focus here is on the indications that are necessary before any such selection process can engage.

Indications of interaction potentialities are anticipative. They implicitly predicate that *this* environment is one that *would* support such an interaction, should that interaction be selected, and, thus, that the indication is *true*. Such potentialities will hold in some environments and not in others, so an indication presupposes, thus anticipates, that the current environment manifests whatever properties are sufficient to support the indicated interaction. It is these presupposed environmental properties that constitute implicit *content* that is implicitly predicated of the environment. It is the presence or absence of that content that makes the anticipation true or false.

Bearing truth values, being true or false, is the basic normative property constituting representationality, so we here have the emergence of a primitive kind of representation. Indications of potential interactions is not a canonical form of representation, but the basic model has the resources for addressing more complex kinds of representing.

One important resource has already been mentioned: indications of potential interactions can branch into multiple possibilities — a fly here, a fly there, a worm somewhere else. Another crucial resource is that such indications can *iterate* in the sense that some interactions can create the conditions for others. The frog might have indications that, if it were to move a little to the left, another worm and another fly might come into range.

Branching and iterating indications of potential interactions can generate vast and complex webs of anticipated possibilities. Such webs are a primary resource for more complex representing. For example, consider a child's toy block. It offers possibilities of multiple visual scans and multiple manipulations. Furthermore, any one of these possibilities can be reached from any other: the subweb of indications is internally completely reachable. Such a subweb, in turn, is invariant under many other possible interactions and many other processes that could occur in the environment: the toddler might leave the block on the floor or put it away in a toy box, but the possibility of returning and re-accessing the possibilities afforded [10] by the block would remain. That subweb of

[9] Truth value, especially the possibility of being false, is difficult to account for in a pure encodingism model: if the encoding, or signification, relationship exists, then the encoded, or signified, exists, and the purported representational relationship is true. But if the encoding relationship does *not* exist, there is nothing to be false; there is no account for the possibility of the representational relationship existing but being false (Bickhard 2009).

[10] The use of the notion of affordance here is deliberate. Gibsonian affordances and indications of interactive possibilities share some basic intuitions. But (indications of) Gibsonian affordances are not considered to have truth value, and cannot iterate (though they might branch), thus cannot form webs. See Bickhard (2016).

possibilities, however, is not invariant under all possibilities: if the block were to be burned or crushed, the subweb of interactive potentialities would no longer be available.[11,12]

At this point in this discussion, we have a *process metaphysics*, which enables a model of *metaphysical emergence*, which permits a model of *normative functional* emergence, within which a model of *truth value* bearing indicative or anticipatory functional processes can be constructed. Such indications are necessary for action selection for any complex agent. Such indications, in turn, show promise to be able to account for representation in general.

Some Consequences for Perceiving and Language(Ing)

Standard information processing and computational models posit representation entering cognitive processes via perceptual transduction, or sensory encoding, and emerging via action and utterances. The interactive model outlined above does not support either end of these assumptions about cognitive information flow. Here I will briefly outline some differences in models of perceptual and language processes.

Situation Knowledge and Apperceiving

In complex agents, webs of indicated interactive potentialities extend far beyond the immediate interactive environment. They include, for example, (interactive) knowledge of how to get back to the toy block from another room for a toddler, and knowledge of how to get home from work for an adult. Such webs constitute the agent's *situation knowledge*, interactive knowledge of the space of interactive potentialities from the current situation.

The potentialities available for an agent in a situation do not remain static, but are ever-changing with the agent's actions and processes that are ongoing in the environment. The situation knowledge web must be continuously updated and maintained. These processes of updating and maintaining situation knowledge constitute processes of *apperception*.

Interactions with the environment can both detect or differentiate environments and induce changes in environments — perhaps both at the same time. Differentiation of environments occurs via interactions that manifest functional flows: such a flow differentiates that this environment is one of those that supports that flow. Such differentiations are a basic form of *contact* with the environment. Note that what those supporting conditions are is not *represented* by the differentiating interaction; they are differentiated.

Such differentiations, nevertheless, serve to modulate ongoing apperceiving. This environment, for a frog, for example, might be one in which an indication of the possibility of flicking one's tongue in a certain direction would yield eating. The indications set up on the basis of contact with the environment constitute presuppositions about that environment that are anticipated to hold. They constitute truth-bearing

[11] This model is essentially Piaget's model of the representation of a toy block (Piaget 1954), presented in the framework of the interactivist model. Such borrowing is possible because both models are action based.
[12] Another kind of representation that needs to be accounted for is that of abstractions, such as the number 3. This requires some additional resources, but they are also available: see Bickhard (2009, in preparation).

content about that environment. *Contact*, thus, modulates the apperceiving of situation knowledge *content*.

The crucial point here, for current purposes, is that differentiating interactions modulate apperceiving, and that physiological specializations for some kinds of such differentiating interactions have *evolved primarily for* such modulations. These are classic sensory systems.[13]

Note that a differentiating interaction *with null outputs* looks like a classic input processing model of perceiving, except that the differentiations thereby induced are — in these classic models — construed as representing whatever it is that has been differentiated. Not so in this model: differentiations differentiate, but only anticipatory content has truth value.

Language

All engagement with the environment is via interaction. This holds with respect to perceiving, and it also holds with respect to language: utterances are *not* transmissions of encoded contents into the world to be decoded by audiences.

Roughly, utterances are interactions with socially common understandings. As interactions, they alter such common understandings into resultant understandings (so long as the utterance is successful). Those common understandings involve interactive representations about the world, though that is not all that they comprise, and, thus, utterances induce changes in socially common interactive representation of the world. They may induce representation of a property of some object or situation; they may make clear that some knowledge that is in fact *common* among the social participants is in fact *commonly known* to be common; they may introduce a new topic; and so on.

For current purposes, the crucial point is that utterances are not encoded transmissions. They are interactions, such as with the toy block, but with social realities rather than physical realities (Bickhard 1980, 2009, 2015a, in preparation).

Encodingism

The model outlined here involves a model of representation, but it is not a standard model. For one difference, standard models conflate what I have called contact with content: contact differentiations are construed as representing whatever is differentiated, especially for presumed "no output" sensory "transductions". There is a more general way of characterizing standard models, however: they assume that all representation is constituted as encodings. They are versions (of which there are many) of encoding*ism*.

Encodings clearly exist, and are especially important in today's technological world. But encodings are necessarily derivative forms of representation: they stand-in for other representations. Those other representations might themselves be encodings, but such a hierarchy must bottom out with some form of representation that is not itself an encoding, on pain of incoherence: a presumed bottom level encoding has nothing to stand-in for, and, thus, cannot exist as an encoding at all. If there is a basic level of representation, it cannot be constituted as encodings.

[13] (Partial) convergences here with Gibson should be clear (Bickhard and Richie 1983).

Encodings must be interpreted; sign into signified. In order to do so, the interpretive agent must already know the encoding elements and the relationships among them: all relevant representations must already be in place. A transduction of one physical or biological phenomenon into another does not constitute an encoding, except perhaps for an external observer who already knows about — represents — all of the relevant phenomena. This is so whether the transductions occur in multicellular organisms with nervous systems, or in single cells engaged in metabolic processes.[14]

Encodingism requires a base of representations that can generate further representations. But that base cannot itself be encodings. Encoding*ism* cannot account for its own base, its own foundation. It cannot account for the (emergent) origins of representation at all.

Another problem facing encodingism models is that encodings are supposed to be constituted as some special kind of correspondence — informational, nomological, structural — that constitutes an encoded representation of whatever the correspondence is with. This makes it difficult to account for the possibility of a representation being in error — being false. If the special correspondence exists, then the purported representation exists, and it is correct. If the special correspondence does not exist, then the representation does not exist. There is no third possibility that could model a special correspondence encoding existing but being in error.[15]

Such problems afflict any two-part model of representation: a representation and a represented. If content is defined in terms of the represented, then it is unclear how the representation can be false.

Three-part models can overcome this difficulty (though they too can have their own fatal problems). A representation, a content, and a represented, enable the possibility that the content is falsely attributed to the represented.[16] In the interactivist model, the content, constituted as functional presuppositions, can be false concerning the environment.

A deeper problem involves not just the possibility of error, but the possibility of *organism detectable* error. Agents can, in principle and fallibly, detect error in their own representations. This is what drives error guided behavior and error guided learning. But a classic skeptical argument holds that, in order to determine whether or not our representations are correct, we would have to step outside of ourselves and compare what we think we are representing (content) with what is actually present (represented) to see if the one actually applies to the other. We cannot step outside of ourselves, so we cannot determine the truth or falsity of our own representations. This is a radical skeptical argument, and it has withstood centuries of attempts to refute or overcome it.

The interactivist model *does* transcend the radical skeptical argument by being pragmatically future-oriented instead of passively past-oriented — instead of being a spectator model (Dewey 1960/1929; Tiles 1990). (Functional) anticipations can be

[14] Transduction does generate correlated phenomena, and these are not only useful, but essential to the general control and modulation functions in cells and organisms. Transduction, however, does not generate, in itself, anything with truth value, and, thus, does not generate representation.

[15] There was a minor industry in the 1980s and 90s attempting to address this problem, but without success (Bickhard 2009, 2014; Dretske 1988; Fodor 1987, 1990; Cummins 1996).

[16] Two part models derive in "recent" history from Mill and Russell. Three part models from Brentano and Frege, though Frege's "sense" is not mental or psychological, and, thus, suffers its own problems. Twardowski discussed content within a Brentanian framework, but did not have a model for it (Poli 1996).

determined to be true or false by waiting for, or engaging, the future to find out if that future fits within the anticipated range. Such truth or falsity of process anticipation is accessible for modulating behavior and learning (Bickhard 2009).

Information is Not Representation — Except when It is

There are a number of perspectives on these issues. I have selected that of emergent truth value for this discussion, but another that deserves mention is that of information. Information, construed as being 'semantic' or representational, is at the center of contemporary cognitive science and cognitive psychology. It is also in the historical core of biosemiotics (e.g., Hoffmeyer and Emmeche 1991).

Information has received 'natural' definitions in terms of being constituted as correlation. Correlation, if it exists, is factual. Attempts to use correlation to model representation require that it somehow become normative. Among other requirements, this involves accounting for the possibility of error (and organism detectable error). As mentioned above, this is intrinsically difficult for two part models, of which correlational, informational, models are primary examples.

The seduction of correlational models (or any two part model) stems in large part from the fact that, from the perspective of an *external observer* who knows all about the correlation (or other form of encoding), the "encoding" can be taken as the basis for inference about the "encoded" — can be taken as offering semantic information about the "encoded". But organisms cannot be external observers on themselves, and, thus, this does not work for basic or emergent representing.

Correlation can exist for multiple kinds of reasons. Even A and B both being correlated with X can yield A being correlated with B, and, thus, with an informational (in the sense of correlation) relationship between A and B. A different kind of basis for correlation occurs if A modifies B in some way, perhaps even causes B, or modulates ongoing processes in B. A general perspective on such kinds of relationships is offered by control theory: modulation is a control relationship (though more general than feedback per se).

So, another perspective on issues of information as representational is the question of whether or not control relationships are representational relationships. Processes in single cells, for example, are mutually and complexly modulating, and so constitute representational — sign — relationships in general *only if* modulation per se suffices for representation. It should be clear by now in this discussion that modulation does not so suffice.

There is one kind of case, however, in which control theoretic modulation does ground representing — when it is anticipatory. In agents in which there are indications of potential interactions, such indications constitute modulations of further activity, and are thus in that sense control theoretic. But they are representational not in virtue of their being informational, but rather in virtue of their being anticipatory. Information as factual correlation per se is not normative; information as anticipatory is.[17]

[17] Modeling such normativity requires modeling how control theory relates to *pragmatic action* (Arnellos et al. 2012; Bickhard 2009; Joas 1993; Rosenthal 1983; Vehkavaara 2003, 2010, 2011).

Functional Processes in the Brain

In order to elaborate a bit further on the differences between this model and others, I will present a very brief outline of how such anticipatory processes occur in complex brains. This will be only a skeleton of the overall model, but enough to illustrate how anticipatory brain processes occur.

The key point is that there are multiple physical and temporal scales of activity in local domains of the brain (especially in cortex). The larger, slower processes are constituted by volume transmitters, slow wave potential movements in silent neurons, multiple astrocyte processes, and so on. Smaller and faster processes are constituted in gap junctions, classical synapses, and so on.[18] Crucially, these processes modulate each other, and, on the time scales of the faster processes, the slower processes are approximately constant — the slower processes set parameters for the faster processes (Bickhard 2015b, 2015c).

Parameter setting for ongoing dynamic processes is the dynamic equivalent of programming for passive computational systems. The slower processes, thus, 'program' the faster processes, even inducing and modulating attractor landscapes within which the faster processes proceed (Bickhard 2015b, 2015c).

The focal point here is that the slower processes 'set-up' the faster processes for near-future activity, and that such set-up might turn out to be appropriate to what actually eventuates, or it might not. The set-up from the slower processes is *anticipatory*, and it can be in error — it has truth value. The fundamental functional architecture of the brain rather directly realizes the basic anticipatory model that has been being outlined (Bickhard 2015b, 2015c).[19]

Functional Scaffolding

Encodings require a non-encoding base. The model outlined above could provide such a base. Does it have any other consequences? It does: it is not simply a model of the nature of basic representational atoms out of which other representations are combinatorically constructed. Here are two such consequences.

The first is that any action based model, including this one, forces a constructivism. In models of cognition and representation that presuppose a passive mind, it might be assumed that the world impresses itself into the mind like a signet ring into wax — or transduction or induction or information, and so on.

There is no such temptation for action based models: it is not plausible that the world could impress a(n successful) action system into a passive mind. An action based model forces a constructivism.

Furthermore, baring prescience, such constructions must be tried out and selected out if they do not work. The constructivism must be a variation and selection constructivism, an evolutionary epistemology (Campbell 1974).[20]

[18] It is simply false that neurons are the only functional cells in the brain, and false that neurons are all integrate-and-fire, or passive threshold switch, elements (Bickhard 2015b).

[19] It is clear that metabolic modulatory processes in a single cell occur at differing time scales. The extent to which those will constitute anticipatory modulatory "set-ups" is not yet as clear.

[20] Note that an evolutionary epistemology requires the possibility of organism level error detection.

Some constructive processes may work with a fixed realm of resources for the constructions, but others, in more complex agents, may realize recursive constructivisms, in which previous constructions are part of the resources for new constructions.[21] A recursive constructivism introduces new (emergent) properties.

In particular, consider a problem encountered by an organism that requires a highly complex construction to be able to solve or resolve it. Such a highly complex construction may be unlikely to be produced by the unforesighted constructive processes. If, however, some constructions that are not successful in a full environment of selection processes could have some of those selection processes blocked, then some of those otherwise unsuccessful constructions might become viable in that 'protected' environment. Still further, it becomes possible, in some cases, for several of the protected constructions to form a constructive trajectory in the sense that each one can serve as the base for a next one, and each one is accessible by much less complex constructions — thus, more likely constructions — than the full task-adequate construction. And finally, if that trajectory of constructions ends with a full task-adequate construction, then the blockages of selection pressures can be removed. They will have *scaffolded* the full construction of the task-adequate processes.

This is related to, but broader than, standard models of scaffolding in terms of interiorization of externally provided coordinations (or other knowledge). Among other consequences, it makes sense out of the notion of *self*-scaffolding: a person can block selection pressures (e.g., focus on sub-problems, move to an ideal case, etc.) for themselves, but cannot provide knowledge to themselves that they do not already have (Bickhard 1992).

Such a model of functional scaffolding requires an underlying evolutionary epistemological constructivism, and such a constructivism is forced by an action based model of cognition — a pragmatic model of knowledge.

Ongoing Emergence

Another consequence has to do with the sense in which the interactivist model is a model of representational emergence. If representation can be emergently constructed out of non-representational phenomena, such as organizations of modulatory relations among processes, then there is no reason to restrict such emergent construction to some fixed foundational base of representations. It becomes possible to model ongoing representational emergence as an intrinsic part of thought processes, rather than in terms of retrieval from some prior encyclopedia or data store of representations. In that sense, cognitive thoughts can literally "pop into" existence in thought processes within ongoing dynamic processes.

This is, arguably, yet another difference, and an advantage, of action based models in general, and the interactivist model in particular. This is, arguably, the manner in which thought actually occurs. For current purposes, it suffices to note that this is not a possibility at all within standard models of representation and cognition, but is easily modeled within the interactivist framework. The difference in the model makes a difference in what further models it enables.[22]

[21] And some may realize a meta-recursive constructivism, in which the processes of construction are themselves being ongoingly constructed (Allen and Bickhard 2011a, 2011b; Campbell and Bickhard 1992).

[22] Note that, once it is realized that ongoing emergence is a real and likely metaphysical possibility, the general point should hold with respect to any recursively constructive process, including evolution.

Conclusion

A model of cognition and representation must account for the normativity of truth value. This can be in terms of an interpreter providing that normativity in the range of encoding cases, but encodings per se cannot account for their own base of representations — encodings are stand-ins, and must have representation already available to be stood-in for. In particular, control-theoretic correspondences or correlations established by standard physical or biological processes do not in themselves yield normativity.

I have outlined a model of representational normativity as emergent in the anticipatory activity of indications of potential interactions that are necessary for action selection in complex agents. This model, in turn, requires a model of normative emergence more generally, which requires a model of metaphysical emergence more generally. Without such possibilities of metaphysical emergence, we are restricted to some form of dualism between the natural world and the realm of normativity.

Emergence per se cannot be modeled within a substance or particle framework. The historical origin of such frameworks was aimed precisely at precluding emergence, and they have done a very good job of that for over two millennia. A shift to a process metaphysics, on the other hand, makes non-epiphenomenal emergence “easy” to account for: organization is intrinsic to process ‘causal’ influence, so differing organization yields differing, emergent, ‘causal power’. Further, there are strong independent grounds for recognizing and accepting a process metaphysics, both with respect to logical considerations and with respect to contemporary physics.

The hierarchy of grounding relations from process metaphysics to metaphysical emergence, to normative emergence, to representational emergence, is an integrated framework. No part of it stands without the rest. Together, the framework is an initial, skeletal start to re-integrating the metaphysical split that has descended from the ancient Greeks.

References

Aitchison, I. J. R. (1985). Nothing’s plenty: The vacuum in modern quantum field theory. *Contemporary Physics, 26*(4), 333–391.

Allen, J. W. P., & Bickhard, M. H. (2011b). Emergent constructivism. *Child Development Perspectives, 5*(3), 164–165. doi:10.1111/j.1750-8606.2011.00178.x. Invited.

Allen, J. W. P., & Bickhard, M. H. (2011a). Normativity: A crucial kind of emergence. *Human Development, 54*, 106–112. doi:10.1159/000327096. Invited.

Arnellos, A., Bruni, L. E., El-Hani, C. N., & Collier, J. (2012). Anticipatory functions, digital-analog forms and Biosemiotics: Integrating the tools to model information and normativity in autonomous biological agents. *Biosemiotics, 5*, 331–367.

Bickhard, M. H. (1980). *Cognition, convention, and communication*. New York: Praeger Publishers.

Bickhard, M. H. (1992). Scaffolding and self scaffolding: Central aspects of Development. In L. T. Winegar & J. Valsiner (Eds.), *Children’s Development within social contexts: Research and methodology* (pp. 33–52). Hillsdale: Erlbaum.

Bickhard, M. H. (2000). Motivation and emotion: An interactive process model. In R. D. Ellis & N. Newton (Eds.), *The caldron of consciousness* (pp. 161–178). Amsterdam: J. Benjamins.

Bickhard, M. H. (2003). An integration of motivation and cognition. In smith, L., Rogers, C., Tomlinson, P. (Eds.) *Development and motivation: joint perspectives*. Leicester: British Psychological Society, monograph series II, 41-56.

Bickhard, M. H. (2009). The interactivist model. *Synthese, 166*(3), 547–591. doi:10.1007/s11229-008-9375-x.

Bickhard, M. H. (2014). What could cognition be, if not computation … or connectionism, or dynamic systems? *Journal of Theoretical and Philosophical Psychology, 35*(1), 53–66. doi:10.1037/a0038059.

Bickhard, M. H. (2015a). The social-interactive Ontology of language. *Ecological Psychology, 27*(3), 265–277. doi:10.1080/10407413.2015.1068656.

Bickhard, M. H. (2015b). Toward a model of functional brain processes I: Central nervous system functional micro-architecture. *Axiomathes, 25*(3), 217–238.

Bickhard, M. H. (2015c). Toward a model of functional brain processes II: Central nervous system functional macro-architecture. *Axiomathes, 25*(4), 377–407.

Bickhard, M. H. (2015d). The metaphysics of emergence. *Kairos, 12*, 7–25.

Bickhard, M. H. (2016). Inter- and en- activism: Some thoughts and comparisons. *New Ideas in Psychology, 41*, 23–32.

Bickhard, M. H. (in preparation). *The whole person: Toward a naturalism of persons — contributions to an ontological psychology.*

Bickhard, M. H., & Richie, D. M. (1983). *On the nature of representation: A case study of James Gibson's theory of perception*. New York: Praeger Publishers.

Campbell, D. T. (1974). Evolutionary epistemology. In P. A. Schilpp (Ed.), *The philosophy of Karl popper* (pp. 413–463). LaSalle: Open Court.

Campbell, D. T. (1990). Levels of organization, downward causation, and the selection-theory approach to evolutionary epistemology. In G. Greenberg & E. Tobach (Eds.), *Theories of the evolution of knowing* (pp. 1–17). Hillsdale: Lawrence Erlbaum Associates.

Campbell, R. J. (2015). *The metaphysics of emergence*. New York: Palgrave Macmillan.

Campbell, R. L., & Bickhard, M. H. (1992). Types of constraints on Development: An Interactivist approach. *Developmental Review, 12*(3), 311–338.

Christensen, W. D., & Bickhard, M. H. (2002). The process dynamics of normative function. *The Monist, 85*(1), 3–28.

Cummins, R. (1996). *Representations, targets, and attitudes*. Cambridge: MIT Press.

Davies, P. C. W. (1984). Particles do not exist. In S. M. Christensen (Ed.), *Quantum theory of gravity* (pp. 66–77). Bristol: Adam Hilger.

Dewey, J. (1960/1929). *The quest for certainty*. New York: Capricorn Books.

Dretske, F. I. (1988). *Explaining behavior*. Cambridge: MIT Press.

Fodor, J. A. (1987). *Psychosemantics*. Cambridge: MIT Press.

Fodor, J. A. (1990). *A theory of content and other essays*. Cambridge: MIT Press.

Fraser, D. (2008). The fate of "particles" in quantum field Theories with interactions. *Studies in History and Philosophy of Modern Physics, 39*, 841–859.

Gill, M.-L. (1989). *Aristotle on substance*. Princeton: Princeton University Press.

Graham, D. W. (1997). Heraclitus' criticism of Ionian philosophy. In C. C. W. Taylor (Ed.), *Oxford studies in ancient philosophy* (Vol. XV, pp. 1–50). Oxford: Oxford University Press.

Graham, D. W. (2006). *Explaining the cosmos*. Princeton: Princeton University Press.

Halvorson, H., & Clifton, R. (2002). No place for particles in relativistic quantum Theories? *Philosophy of Science, 69*(1), 1–28.

Hobson, A. (2013). There are no particles, there are only fields. *American Journal of Physics, 81*, 211. doi:10.1119/1.4789885.

Hoffmeyer, J. Emmeche, C. (1991). Code-duality and the semiotics of nature. In (Eds.) M. Anderson, F. Merrell *On Semiotic Modeling*. (117-166). Berlin: Mouton de Gruyter.

Huggett, N. (2000). Philosophical foundations of quantum field theory. *The British Journal for the Philosophy of Science, 51*(supplement), 617-637.

Joas, H. (1993). American Pragmatism and German thought: A history of misunderstandings. In H. Joas (Ed.), *Pragmatism and social theory* (pp. 94–121). Chicago: University of Chicago Press.

Kim, J. (1991). Epiphenomenal and supervenient causation. In D. M. Rosenthal (Ed.), *The nature of mind (pp. 257–265)*. Oxford University Press. Causal regularities.

Kim, J. (1993). *Supervenience and mind*. Cambridge: Cambridge University Press.

Kuhlmann, M., Lyre, H., & Wayne, A. (2002). *Ontological aspects of quantum field theory*. River Edge: World Scientific.

Millikan, R. G. (1984). *Language, thought, and other biological categories*. Cambridge: MIT Press.

Millikan, R. G. (1993). *White queen psychology and other essays for Alice*. Cambridge: MIT Press.

Millikan, R. G. (2004). *Varieties of meaning*. Cambridge: MIT Press.

Palmer, J. (2010). *Parmenides and Presocratic philosophy*. Oxford: Oxford University Press.

Pattee, H. H. (2013). Epistemic, evolutionary, and physical conditions for biological information. *Biosemiotics, 6*, 9–31.

Piaget, J. (1954). *The construction of reality in the child*. New York: Basic.
Poli, R. (1996). Kazimierz Twardowski (1866–1838). In L. Albertazzi, M. Libardi, & R. Poli (Eds.), *The School of Franz Brentano* (pp. 207–231). Dordrecht: Kluwer.
Rosenthal, S. B. (1983). Meaning as habit: Some systematic implications of Peirce's Pragmatism. In E. Freeman (Ed.), *The relevance of Charles Peirce* (pp. 312–327). La Salle: Monist.
Sciama, D. W. (1991). The physical significance of the vacuum state of a quantum field. In S. Saunders & H. R. Brown (Eds.), *The philosophy of vacuum* (pp. 137–158). Oxford: Clarendon.
Seibt, J. (2000a). Pure processes and projective metaphysics. *Philosophical Studies, 101*, 253–289.
Seibt, J. (2000b). The dynamic constitution of things. In J. Faye, U. Scheffler, M. Urchs (Eds.), *Things, facts, and events. poznan studies in the philosophy of the sciences and the humanitie* (volume 72, pp. 241-278).
Seibt, J. (2001). Formal process Ontology. In C. Welty & B. Smith (Eds.), *Formal Ontology in information systems: Collected papers from the second international conference* (pp. 333–345). Ogunquit: ACM Press.
Seibt, J. (2003). Free process theory: Towards a typology of Occurings. In J. Seibt (Ed.), *Process Theories: Crossdisciplinary studies in dynamic categories* (pp. 23–55). Dordrecht: Kluwer Academic.
Seibt, J. (2009). Forms of emergent interaction in general process theory. *Synthese, 166*(3), 479–512.
Tiles, J. E. (1990). *Dewey*. London: Routledge.
Vehkavaara, T. (2003). Natural self-interest, interactive representation, and the emergence of objects and Umwelt. *Sign Systems Studies, 31*(2), 547–587.
Vehkavaara, T. (2010). The roles of action in the pragmaticist philosophy. *The Third Nordic Pragmatism Conference*, Uppsala, Sweden, June 1-2.
Vehkavaara, T. (2011). Truth and not much anything but the truth? *Seventh Conference of the Nordic Association for Semiotic Studies (NASS)*, Lund, Sweden, may 6–8.
Weinberg, S. (1977). The search for Unity, notes for a history of quantum field theory. *Daedalus, 106*(4), 17–35.
Weinberg, S. (1995). *The quantum theory of fields* (Vol. 1. Foundations). Cambridge: Cambridge University Press.