Development and Motivation, 41–56
BJEP Monograph Series II, 2

www.bps.org.uk

An integration of motivation and cognition

Mark H. Bickhard*

Lehigh University, Bethlehem, USA

Motivation and cognition are commonly modelled as distinct processes: motivation as some form of initiating and directing—pushing and pulling—behaviour, and cognition as the manipulation of encoded representations in memory. This produces grave difficulties in understanding the interrelationships between them, and their interactions in behaviour and development. I argue for a model of representation and motivation in which they emerge as different aspects of one underlying organization of interactive process. This natural integration yields an equally natural model of the joint development of higher-order motivation and cognition, as interactions with learning and emotional processes are taken into account.

Models of motivation and cognition often have little intrinsic relationship with each other. If, for example, cognition consists of manipulating encoded symbols (such as in the standard information processing paradigm), while motivation is concerned with energizing and directing an action system (such as in the Freudian paradigm), the interface between them is likely to be relatively *ad hoc*. Furthermore, such a fragmented model of mental phenomena is almost certainly false: motivation and cognition have evolved together and develop together and, consequently, must be more strongly integrated in order for their co-evolution and co-development to remain coordinated. If so, such models necessarily misrepresent the nature and interrelationships of motivation and cognition, and provide flawed guidance for developmental and educational policies and interventions.

I will argue, in fact, that such models of cognition and motivation are false in themselves, independent of any issues regarding their interrelationships. The encoding paradigm, for example, including both its symbolic and its connectionist incarnations, faces a multitude of fatal problems, including the fundamental fact that it cannot account for representational content and, thus, cannot account for representation at all. The energizing conception of motivation, in turn, is incompatible with the basic fact

*Requests for reprints should be addressed to Mark H. Bickhard, Cognitive Science, 17 Memorial Drive East, Lehigh University, Bethlehem, PA 18015, USA (e-mail: mark.bickhard@lehigh.edu).

that motivated action only occurs in systems that are, of ontological necessity, open and in ongoing interaction with their environment. Inertness that must be 'energized' is not an option.

Nevertheless, such fragmented models of mind are not only common, but are forced by dominant theoretical approaches and their presuppositions. I outline an alternative model in which motivation and cognition are tightly—ontologically, not merely ontogenetically—integrated, and will illustrate some of its consequences. The alternative model, however, requires changes in theoretical presuppositions, not just their contents.

Metaphysics: Substance and process

The presuppositions of a theoretical approach—even to the level of metaphysical presuppositions—can strongly constrain the kinds of theories that are possible within that approach. In particular, they may well preclude theories of the kind that ultimately prove to be correct. For example, as long as models of fire were presumed to be models of some kind of substance, the phlogiston theory seemed like a good theory, albeit with empirical refinements yet to be worked out (Kuhn, 1970).

The phlogiston example illustrates what I argue is a fundamental metaphysical issue in studies of the mind: substance metaphysics versus process metaphysics. Every science has gone through a historical phase in which it assumed that its basic phenomena were phenomena of some special sort of substance. Fire was thought to be the release of phlogiston; heat was a fluidic substance called caloric; magnetism was a substance; life was constituted in vital fluid; and so on. Every science has moved on from such substance approaches to a recognition that its basic phenomena are phenomena of process: fire is combustion; heat is random kinetic energy; magnetism is a field process; life is a particular kind of far-from-thermodynamic-equilibrium complex system; and so on.

But there is one major exception to this historical generalization: most studies of the mind and mental phenomena still routinely presuppose that they are phenomena of some particular kinds of substances or structures. Genuine process models are difficult to find; most—such as Piaget's—have emerged in one way or another out of the action framework of pragmatism (Bickhard & Campbell, 1989; Joas, 1993).

The historical trend mentioned above already creates a strong presumption in favour of process models, but the case is in fact much stronger. This is not the place to examine the problems and problematics of substance and structure models in detail, but some illustrative ones include the following:

(1) Modern physics shows that there are no substances and no particles (Brown & Harré, 1988; Cao, 1999; Huggett, 2000; Weinberg, 1977, 1995, 1996, 2000). Instead, there are quantized fields, in which the quantization of field processes superficially appears as a particle count. However, the number of oscillatory waves in a guitar string is also restricted to discrete possibilities, and there are no guitar sound particles. The world is composed of quantized field processes at all scales, large and small (Bickhard, 2000a).

One consequence of a shift from a particle or substance framework to a process framework is that explanatory defaults reverse: stability is the default for substances and structures, and change must be explained; while change is the default for processes, and stability must be explained. This has critical implications for phenomena such as motivation or psychopathology: the fundamental nature of what is taken as problematic and as requiring explanation is reversed (Bickhard, 2000b; Bickhard & Christopher, 1994; Christopher & Bickhard, 1994).

(2) Substance and particle models make genuine causally efficacious emergence impossible. All causality is located at the level of the fundamental particles (or substances), and all higher-level phenomena are just the working out of the causal dance of the particles at the basic level.

In particular, higher-level phenomena, such as mental phenomena, are causally epiphenomenal (Bickhard, 2000a; Kim, 1993). Such a position forces a micro-physicalism, at the lowest level of particles, as the only causally efficacious level of reality and precludes any genuine naturalism (Bickhard, 2003). It faces serious problems with prima facie causal efficacies of higher-level phenomena, such as atoms, chemical properties and interactions, biological phenomena, and psychological and social processes. To construe these entire realms as epiphenomenal illusion, akin to the illusion of motion in a movie, as is forced by such a micro-physicalism, is a prima facie refutation of the substance presuppositions that compel such a stance.

(3) A corollary of the second point is that no genuinely new kinds of phenomena can emerge; new kinds of substance or particle cannot emerge, instead, the original ones can blend or structure themselves in differing ways. But most of what the sciences are interested in, including mental phenomena, did not exist at the time of the Big Bang, and does exist now. So it has to have emerged. Any model that makes such emergence impossible is thereby refuted (Bickhard, 2000a).

This problem is especially acute for normative phenomena, such as representation, rationality, learning and so on: normativity is not generally accepted as endemic in the physical world so, if emergence, and thus the emergence of normative phenomena, is impossible, then virtually all mental phenomena are impossible. More to the current point, *working within* a substance metaphysics makes *accounting for* such normative phenomena impossible.[1]

There are numerous additional problems with substance and particle approaches (Bickhard, 2000, 2003), but these points suffice to indicate that they face serious difficulties. A process metaphysics is correspondingly recommended, although not necessarily easily honoured: substance and structure presuppositions can be quite subtle and unnoticed.

Representation and fragmentation

One aspect of psychological phenomena that is still caught in substance presuppositions is that of cognition, especially with respect to representation. Substance models of representation are at least as old as Plato's and Aristotle's signet rings pressing their

[1] *So long as such conceptual possibilities as dualism or idealism are eschewed. So, the point is that a* naturalistic *account of normative phenomena is precluded (Bickhard, 2003).*

forms into wax.[2] Such an impressing-into-wax creates a *correspondence* between the impression in the wax and the form that it is supposed to represent. This is the basic kind of substance model of representation that has been pursued ever since.[3] Locke's blank sheet of paper is just a slightly technologically advanced version of something to receive correspondences, whether singular or structural, and contemporary talk of 'transduction' or 'sensory encoding' is a suitably updated version of the same basic model (Bickhard, 1993; Carlson, 2000; Fodor, 1975, 1991).

Unfortunately, correspondence approaches to the nature of representation are fatally flawed as models of representation, and they yield equally flawed models of interrelated mental phenomena as well.

Encoding models of representation

There is a large family of problems with correspondence models of representation, some very old and some being discovered recently. Furthermore, there are multiple subordinate families of problems, one for each of the many particular forms of such correspondence models (Bickhard, 1993, in press; Bickhard & Terveen, 1995). One way in which correspondence models differ, for example, is in terms of what kind of correspondence is taken to be the special representation-constituting kind of correspondence—these can posit causal correspondences, informational correspondences, nomological correspondences, trained or learned correspondences, and so on. I will not attempt an exhaustive survey of such variants and their general and particular problems but, as for substance metaphysics more broadly, will attempt to demonstrate via a few examples that such models are in serious difficulty.

Encodings

There is, in fact, a class of correspondences that *are* representational: encoding correspondences. Correspondence models of representation in effect, and sometimes explicitly, assume that all representation has the nature of encodings. In Morse code, for example, '. . .' encodes 's'. The encoding correspondence is a representational correspondence, but it generates a circularity if encoding is used to account for representation in general: an encoding functions as such only if an interpreting agent knows both ends of the encoding relationship, and knows the encoding relationship itself. '. . .' encodes 's' only if '. . .' and 's' and the encoding relationship between them are known. But this kind of knowledge is representational knowledge; it is precisely what we seek to model. Artificial codes of this sort are useful because they change the form of the representation, and a new form can have properties that the original form does not. '. . .', for example, can be sent over telegraph wires, while 's' cannot. They are not generators of new representations in themselves; codes borrow representational

[2] *Neither Plato nor Aristotle was a pure substance philosopher. The involvement of forms and of the soul or psyche, in differing ways in the two frameworks, transcends some of the restrictions of substance presuppositions. Nevertheless, there does tend to be a continuation of the intuition of 'like represents like' carried over into the more sophisticated kinds of representation and cognition (Bickhard, 2003; Gill, 1989)*

[3] *A second theme of representational models is also to be found in the 'ring in wax' analogy: a representation being similar to that which it represents. Similarity models, however, suffer from immediate special problems, especially having to do with generality and abstraction. For example, is the representation of a triangle similar to an isosceles or to a scalene triangle, or how can you model a representation of truth or beauty? Similarity models and correspondence models are at root deeply related: a similarity, or, in more modern form, an iso- or homo-morphism, is a correspondence of structure – of relations among points – as well as a correspondence of points to points. There are some interesting issues here, but they are not germane to the topics that I want to pursue in the text.*

powers from what is encoded: '. . .' borrows its representational character from 's'. It does not generate any new representation and, therefore, cannot account for the grounding representation for any such encoding.

Circularity

The general point, furthermore, does not depend on the social arbitrariness of something like Morse code. We might find the claim that neutrino counts encode properties of fusion in the interior of the sun. This is a natural correspondence, not a conventional one. However, it is in itself only an informational correspondence (and also a causal and nomological correspondence). It functions as an encoding, or representational, correspondence only for someone who knows about fusion process and neutrino counting and the relationships between them. Again, as an account of the fundamental nature of mental representation, this generates a circularity.[4]

A differing perspective on this circularity can be found in Piaget's argument that our mental representations of the world cannot be copies of the world, because, if they were, we would have to already know the world in order to construct our copies of it (Piaget, 1970). Still another perspective is the radical sceptical argument that we cannot ever check whether our representations are accurate because, in order to do so, we would have to have some epistemic access to the relevant parts of the world that is independent of our representations in order to make the comparison. We do not have any such independent epistemic access, so any such check is circular.

Over-extension

This basic circularity is just one of a family of fatal flaws in correspondence, or encoding, models of representation. Consider that all of the proposed forms of correspondence—informational, lawful, causal and so on—are ubiquitous throughout the universe. Every instance of every causal law, for example, is an instance of a causal correspondence, an informational correspondence, and a nomological correspondence, and causality is not the only class that yields such proliferations. Informational correspondences, for example, do not even require causal connection. Furthermore, almost none of these are representational. At best, these enormous classes of correspondences require drastic pruning down to the representational correspondences.

It might appear that structural correspondences are more particular than causal, informational or nomological correspondences and, therefore, not as subject to the charge of massive over-extension beyond anything that is representational. This appearance, however, evaporates once it is recognized that the point-to-point correspondences, the relation-to-relation correspondences and even what counts as a point at all are all logically arbitrary and subject to unbounded variation in how they are defined and which ones 'count'. Every aspect of a purported structural correspondence is unboundedly arbitrary and, therefore, can be defined everywhere.

Further, all such correspondences iterate and proliferate in time. Any activity in my occipital lobe that is in correspondence (of whatever kind—causal, perhaps) with a table in front of me is also in correspondence (of that kind) with activities in my retina, with the patterning of light in front of me, with the quantum processes in the surface of that table, with the table a second ago, with the table yesterday, with the construction

---

[4] *That the only genuine representational correspondences are encodings has led me to dub correspondence models of representation in terms of their presupposition that all representations are encodings: encodingism.*

of the table, with the growth of the trees from which the table was made, with the creation of the sun that helps those trees grow, and so on all the way back to the Big Bang. Which one of this proliferation of correspondences is the representational correspondence? Again, at best, drastic principled pruning of some sort is required.

Normativity: The possibility of error

Correspondence models of representation are massively over-extended, and they are circular. Another perspective on them focuses on the fact that they cannot account for the normative aspects of representation. They cannot account for the simple possibility of representation being in error. In such a model, if the favoured special kind of correspondence exists, then the representation exists, and it is correct. If the correspondence does not exist, then the representation does not exist. But the correspondence either exists or does not exist. Those are the only two modelling possibilities. The modelling task, however, requires three cases to be modelled: the representation exists and is correct, the representation exists and is incorrect, and the representation does not exist. Three cases cannot be modelled in a model that has only two categories. This inability to model representational error has generated a small industry of attempts in the last decades, but without success (Bickhard, 1993, in press; Cummins, 1996; Dretske, 1988; Fodor, 1990, 1991, 1998; Levine & Bickhard, 1999; Millikan, 1984, 1993).

System detectable error

An even stronger desideratum for models of mental representation is that they not only account for the possibility of representational error, but account for the possibility of system or organism detectable representational error. Not all organisms are capable of such detection, but certainly some of them are some of the time. So any model that makes such detection impossible is thereby refuted. If organism-detectable representational error is not possible, then error-guided behaviour and error-guided learning are not possible.[5] No model in the literature, other than that to be outlined below, even attempts to account for system detectable error.[6,7]

Substance approaches to representation have grave difficulties. These difficulties might be taken as refutations if there seemed to be any alternative, but there has not appeared to be any alternative prior to the advent of pragmatism a little over a century ago.

Models of fragmented minds

Encoding models of representation not only encounter fatal difficulties as models of representation, but must fit into models of mental phenomena more broadly, and they (and their underlying substance presuppositions) wreak foundational damage with respect to this broader range of considerations as well. In particular, they induce

[5] *Note that the strong sceptical argument mentioned above is an argument that such organism error detection is not possible.*

[6] *Connectionism, for all its differences with the symbolic and information-processing frameworks, does not differ in these fundamental respects with regard to the assumed nature of representation. A symbolic system has transduced encodings; a connectionist system has trained encodings. Neither can solve or avoid the problems of encoding or correspondence models of representation (Bickhard & Terveen, 1995).*

[7] *For more extensive discussions of problems with encoding models in general, and with specific models of representation available in the literature, see Bickhard (1993, in press) and Bickhard and Terveen (1995).*

models of fragmented minds, in which various aspects of mental process are reified into distinct subsystems and modules.

A bank of encoded representations is inert. What is required for its formation and use is a perceptual process to generate them and a cognitive process to manipulate them, not to mention a language process to re-encode them and transmit them into the world. In itself, such a cognitive system would not act and has no need for any action system. In particular, under these modelling assumptions, there is no need for action in order for the system to be a cognitive system, with genuine representations.

We know, however, that animals do act, so we need some sort of action module. Such a subsystem needs to access, and be guided by, the representational information in the encoding bank; it needs to be energized into activity at appropriate times and in appropriate circumstances, and in some sense to seek appropriate outcomes of its interactions. We might also want to account for memory, consciousness, values and so on, and each one of these can also have its own dedicated subsystem.

The basic split here is between representation and action: correspondence models of representation do not need action, so any interface between cognition and action, including issues of motivation, is theoretically *ad hoc* (Bickhard, 1997a). There is little intrinsic constraint in the relationships between cognition and action, at least in such models. Moreover, the underlying substance and structure assumptions can permeate further, to generate a proliferation of modules and submodules, systems and subsystems. As discussed earlier, such an architecture is highly unlikely, and thus counts against substance models in general, and encoding models of representation in particular, from an even broader perspective.

The problem of action selection

Substance and structure presuppositions, then, are not acceptable as a metaphysical framework, and, when they do frame explorations of cognition, they yield correspondence models of representation, which are fatally flawed both as models of representation *per se* and as accounts of the representational aspect of mental phenomena more broadly.[8] A shift to a process metaphysics is required, but how is that to be undertaken? In particular, what would a process model of representation look like (Bickhard, 1993, in press; Bickhard & Terveen, 1995)? I approach this question via a prior issue regarding how organisms solve the problem of selecting their actions and interactions.

Complex organisms will generally have numerous actions that are possible at a given moment. Somehow these possibilities must be available for the organism to select among, and somehow that selection must take place. I will focus on just a few aspects of this overall problem.

Some simple cells, perhaps sulphur-consuming bacteria, do only one thing, and do it continuously. Slightly more complex would be bacteria that can swim if they find themselves swimming up a sugar gradient but tumble if they find themselves swimming down a sugar gradient; they can do two things, and can switch between them more or less appropriately. A frog, however, can in general do any of a number of things at a

[8] Piaget's 'structures' are more akin to formal structures, as in mathematics, than to substantial structures. I argue elsewhere, nevertheless, that they involve serious problems, including vestiges of correspondence models (Bickhard, 1992a; Bickhard & Campbell, 1989; Campbell & Bickhard, 1986).

given moment, so the simple triggering of the sugar-seeking bacterium will not suffice. Furthermore, what it would be appropriate for the frog to do will shift from time to time: flicking its tongue at a fly is inappropriate if there are no indications that such tongue-flicking might have a positive outcome.

The frog, or some more complex organism, then, must have some way of indicating what actions and interactions are available to it at a given time, and must select among them based on further considerations, such as their potential utility for achieving goals. They will be of potential relevance to goals in so far as their anticipated outcomes or their anticipated future courses of interaction satisfy heuristic criteria for instrumental movement towards those goals. Indications of currently possible interactions, then, must also include indications of anticipated courses or outcomes of those interactions.[9]

Interactive representation

This brief sketch of a model of action selection is already sufficient to ground a model of at least primitive representation. In fact, primitive representation is already an aspect of the model outlined: no further model-building is required for this basic point, only the pointing out of properties already involved in the model. That is, representation in this primitive sense is not a distinct component or system but instead is a differentiable aspect of any complex system by which an organism selects actions. Representation is an intrinsic aspect of the evolutionary solution to the action selection problem.

The key is to note that the anticipations of future courses of interaction, or of their outcomes, involve presuppositions about the environment.[10] In some environments, an action will fulfil the anticipations, in others not. In some environments, the frog flicking its tongue is likely to succeed in producing eating, while in others it will not. These dynamic presuppositions involved in action anticipations are presuppositions about the environment, and they can be true or false about that environment. This, I claim, is the fundamental emergence of representational truth value.

The dynamic presuppositions of an indicated interaction are the conditions under which the interaction would in fact satisfy those anticipations, in which the interaction would have the indicated outcomes or follow the anticipated course. Implicitly, they

---

[9] *If those indicated future courses or outcomes must themselves be 'represented', then the account being adumbrated will be circular, in that a model of representation will be based on a notion of representation. But those future courses and outcomes need be represented only if they are external to the organism. If they are internal flows of interaction or internal outcome states, then they need only be indicated, and indication can be a strictly functional notion: in a computer architecture, indication can be accomplished with simple pointers. There are good reasons to avoid simple computer models, and good reason to think that they are radically inadequate for understanding human mentality, but the example does make the point that there is nothing mysterious about the function of indication. Of course, once the possibility of representation is granted, there is nothing to prevent the organism from using represented external outcomes as part of its process for action selection.*

A similar problem of potential foundational circularity occurs with respect to the role of goals in this model. If goal conditions must be represented, then circularity appears in a similar manner as with indications of future outcomes. But goals, at least in the most primitive sense, need only be functional set points for conditions, internal conditions perhaps, such as 'above threshold level of blood sugar', that are detected or not, and appropriate control theoretic switching can follow from such detection or failure of such detection. However, detection is not representation, and does not require representation, though, again, representation can be used if otherwise available, so the threatened circularity does not exist (see Bickhard, 1993, in press; Bickhard & Terveen, 1995).

[10] *The notion of dynamic presupposition is a normative one: an interaction dynamically presupposes those conditions under which that interaction would* succeed. *The normative notion of success, in turn, is relative to contributing toward goal attainment, or, more generally, contributing toward the well-being of – being functionally useful for – the overall organism. Such issues of functional normativity are interesting, important and complex, but are not addressed here: see Bickhard (1993, 2000c, 2003, in press; Christensen & Bickhard, 2002).*

are predications about the environment: this environment is of the type that will satisfy the anticipations involved in this interaction. For interaction $\mathbb{P}$, this environment is a $\mathbb{P}$-type environment. And such (implicit) predication will have a truth value.

More sophisticated representations

These simple indications of interactive potentiality may suffice for worms, but perhaps frogs and certainly mammals are capable of much more complex representations, such as of objects and abstractions like numbers. How can an interactive model handle those?

The first step in addressing this question is to elaborate some of the relevant resources available in the model. One of them, in fact, has already been mentioned: indications of interactive potentiality can involve indications of multiple potentialities at one time. That is, such indications can branch.

Recognition of a second resource begins with the recognition that indications of interactive potentiality are necessarily conditional. The bacterium swims if it detects that it is swimming up a sugar gradient. The frog flicks its tongue if it detects something like a moving black dot in an appropriate range of its vision.

How do such detections occur? The simple answer is: via the course and outcomes of previous interactions. That is, if a (or the) previous interaction has in fact ended in one of its anticipated outcomes, then (depending perhaps on precisely which outcome state) a flick of the tongue in such-and-such a manner and direction should yield an opportunity for eating. More generally, the course of an interaction will depend in part on the organization of the subsystem engaging in the interaction, and in part on the environment being interacted with. In some environments, the interaction may end with internal outcome $\mathbb{A}$, while in others it may end in $\mathbb{B}$. Such an interaction can then differentiate $\mathbb{A}$-type environments from $\mathbb{B}$-type environments, though the detection *per se* neither obtains nor creates any available information about what properties characterize $\mathbb{A}$ or $\mathbb{B}$ types of environments. Nevertheless, the differentiation can be quite useful if the organism learns, or has hard-wired, that in $\mathbb{A}$-type environments such-and-such a tongue-flicking with eating as an outcome is possible, while in $\mathbb{B}$-type environments, it is not. That is, such a differentiation can be useful if the organism has available a conditionalized indication of the possibility of tongue-flicking followed by the possibility of eating in $\mathbb{A}$-type environments.[11]

Such conditionalized indications of potentiality are available in the organism even if not being activated at some given time. The frog 'knows' about the relationship between $\mathbb{A}$-type environments and tongue-flicking and eating even when it is underwater and not engaged in the right kind of interactions (visual scans of some sort presumably) to yield the outcome $\mathbb{A}$ at all. Furthermore, the iterated conditional of tongue-flicking yielding eating is also similarly available. More generally, interactive indications not only branch but also iterate, with the outcomes of one serving as the differentiating outcomes for further indications of the next potentialities.

Such branched and iterated (and continuous) organizations of indications of interactive potentiality can form vast and complex webs. It is these webs that provide the answer to the question of how something like objects could be represented.

---

[11] *This is all worded in discrete terms for ease of discussion. More realistically, sets of possible outcome states and their indicative relationships to further potentialities will be more complex, perhaps even continuous in nature.*

In particular, some subwebs of such an overall web will have two special properties. Every point in it will be reachable from every point. This is illustrated by a child's toy block in which every visual scan is reachable from every other via some intermediary manipulations. And such an internally reachable subweb may be invariant under some special class of possible interactions, such as manipulations and transportations. The child's block affords manipulations and visual scans in a fully reachable manner, and this organization of interactive potentialities is itself invariant under many kinds of transportations, locomotions, chewings, and so on—although not invariant under burning or crushing. An internally reachable web of interactive potentialities that has such an invariance *is* (epistemologically) a manipulable object.

Clearly, this is just a translation into the language of the general interactive model of Piaget's model of object representation (Piaget, 1954). It is possible to borrow Piaget's model in this way because both are based on action and interaction as the foundational framework within which representation is modelled. There is not the space to develop it here, but I would offer a similarly Piagetian answer to the question of how an interactive model of representation could model the representation of abstractions, such as of numbers (Campbell & Bickhard, 1986).

While still focused on representation, let me note that the detections upon which indications of interactive potentialities are based are, in most models, taken to be or to generate the paradigm cases of correspondence representation. A simple form of interaction is one in which there are no outputs from the system—a passive processing of inputs. Such passive input processing is the standard model of sensory encoding, as in the visual system (Bickhard & Richie, 1983). Such a detection process does set up informational, perhaps causal and nomological, relationships with whatever the properties (perhaps objects) are that characterize the detected environments, but standard models assume that the input process thereby yields a representation of those properties, with all of the fatal consequences outlined earlier. The interactive model, in contrast, makes use of the environmental differentiations involved but without reifying a detection or differentiation into a representation.[12]

Motivation

Representation, then, is an aspect of processes of action selection: the aspect of environmental dynamic presuppositions. What about motivation (Bickhard, 2000b)? As for representation, the model is already in place; what is required is to bring out the aspect of it that is motivational in nature.

A critical step in arriving at a motivational focus is to clarify what the problem of motivation is. Classically, and in fragmented models in general, the system is inherently passive or inert, and the question that defines motivation is 'What makes the system do something rather than nothing?' The answer has to be in terms of some sort of directional energizers, pushes or pulls or both, that mobilize the action system into real action.

Living beings, however, are far-from-equilibrium systems that must always be in interaction with their environment in order to maintain their far-from-equilibrium

[12] *Furthermore, the representations, the interactive anticipations, that are evoked by a particular differentiation will change from time to time with learning and over time with development, if the organism is capable of such. So, if an infant is in fact seeing an object, there is no temptation to assume that 'an object' is necessarily what is being represented for that infant (Bickhard, 1997b, 2001).*

conditions. The bacterium must swim and tumble under appropriate conditions, or die. The frog must flick its tongue under appropriate conditions, or die. Absence of action is not an option. It is ongoing, continuously. So the relevant question cannot be 'What makes the system do something rather than nothing?' Nothing is not an option; the system will always be doing something so long as it is alive. The relevant question for motivation is 'What makes the system do one thing rather than another?' That is, the problem of motivation is the problem of action selection, not of action instigation (Mook, 1996).

Action selection is the framework within which the representational model has been developed. The overall system is one of functional interaction with the organism's environment, with action selection one of the basic problems involved, and representation at the centre of solutions to the problem of action selection. In other words, representation evolved in the service of motivational problems—selection problems—encountered in interacting so as to keep the organism alive.[13]

Both representation and motivation are aspects of a more fundamental form of process in certain far-from-equilibrium systems. They are not, foundationally, distinct subsystems. I introduce the caveat of 'foundationally' because, having originated in evolution as aspects in this manner, there is nothing to preclude the further differentiation and specialization of subsystems that may be relatively devoted to these functional aspects, similar to the sense in which there is massive differentiation and specialization of subsystems for interaction in the central nervous system that are devoted to the function of detection rather than of manipulation in the environment. We call them sensory systems.

Thus, there will be higher order and more sophisticated versions of both representation and motivation. In the representational case, one example would be that of representations of abstractions, which I address elsewhere (in a generally Piagetian manner). In the case of motivation, I wish to focus on one more sophisticated motivational emergence—roughly, intrinsic motivation—but at least rough characterizations of some properties of learning and emotions are needed to do so.

Some properties of learning, development and emotions

Only a few basic properties of learning and emotions are essential here (Bickhard, 2000b). For learning, the central point is that learning is initiated by error, by failure of the anticipations involved in representations. The organization of system processes in which such anticipations are embedded is destabilized by learning, thereby creating a new trial, a new anticipation, the next time that the same condition is encountered. Conversely, successful anticipations—successful interactive 'knowing' of the object of interaction—will stabilize, and yield the stability of the representations constituted in those anticipations. Such a dynamic suffices for a minimal trial-and-error learning process: success stabilizes, failure destabilizes. Much more is required in order to account for heuristic trials, for the learning of heuristics *per se*, for the development of rationality and logic, and so on, but this minimalist model will suffice for current purposes.

---

[13] *A more careful analysis of the relationships among far-from-thermodynamic-equilibrium processes and an organism's activities in the service of maintaining those far-from-equilibrium conditions can be found elsewhere (Bickhard, 1993, 2000c, 2003; Christensen & Bickhard, 2002).*

Learning and development

Learning, then, is a constructive process—a variation and selection, evolutionary epistemology constructive process (Campbell, 1974). There is little incentive in an action-based model to suppose that the world can impress itself into a passive mind: successful interaction systems cannot be pressed into the mind by the world. They must be constructed, and—so long as those constructions are non-prescient—this will be a variation-and-selection kind of constructive process. If such constructions are each totally independent of others (as might perhaps be the case in simple organisms), then each new construction will start from the same basis and in the same functional context, so there will be no relevant historicity in the overall constructive history of the organism.

If, however, new constructions can make use of, and are in the functional context of, already available successful previous constructions—if the constructive process is recursive—then the process becomes inherently historical, with previous learning framing, constraining and making possible further constructions. Particular domains of construction, for example, may develop that have rich resources for further development, while some other domain may have early constructions, early learning, that make further development difficult or distorted in some way. Furthermore, with such historicity involved, multiple additional sources of constraint on historical trajectories of constructions can come into play. Developmental psychology focuses on such historistic constraints and possibilities regarding constructive trajectories.

Developmental constraints might involve, for example, intrinsic relationships among domains of learning, such as the fact that you cannot learn calculus without having learned algebra first. Or constraints might emerge that depend on what sorts of new constructions are easy to construct given the constructive processes and currently available resources. Constructions, and thus kinds of learning and development, that are too difficult with a particular framework of resources are not likely to occur without appropriate scaffolding (Bickhard, 1992b). I argue that one major intrinsic constraint on constructive trajectories is one that emerges from levels of reflective knowing (Campbell & Bickhard, 1986, 1992). If some sort of knowledge, such as the invariance of number in a set of objects so long as none are added or removed, requires reflection on prior knowledge, such as how to differentiate units and distinguish and keep track of sets, then the dependent form of knowledge cannot be constructed prior to the depended upon form; they must be constructed in sequence. Such levels of knowing impose a major sequential hierarchy on the possibilities of child development.

Emotions

The case of emotions involves an additional complication: there is no consensus on even basic characterizations of the nature of emotion (e.g. Ekman & Davidson, 1994; Frijda, 1986; Griffiths, 1997; Lazarus, 1991; Oatley, 1992). The model that I propose has the notion of interactive anticipation at its core. In particular, anticipations of future interactive processing may involve occasions in which the anticipations break down. This occurs when the situation is novel or difficult. For whatever reason, full anticipations for interactive flow have not been learned. In such a case, the anticipations of interactive processing may anticipate interactive failure, or uncertainty about how to proceed. If a signal of such interactive uncertainty could be fed back into the system as an input to be interacted with, then the system could interact with its own conditions of interactive uncertainty.

This would be useful, among other reasons, because it would allow the organism to develop general strategies for dealing with various kinds of uncertainties, rather than having to wait for actual interactive failure and then engaging learning processes. The first time you encounter a tiger on jungle trail, it would be good to have a general response already available, rather than cycling through various learning trials.

In particular, I propose that emotions are interactions with such internal conditions of interactive uncertainty.[14] Negative emotions emerge when the further anticipations involve anticipations of failure to resolve the uncertainty, and differing kinds of negative emotion involve differing strategies for trying to handle such failures. Positive emotions involve anticipations of success in resolving interactive uncertainty. This can range from the immediate resolution of walking in on your own surprise birthday party to the anticipation of solving a complex problem of a kind that you feel competent to tackle.

An emergent motivation

One of the attractive characteristics of this model is that it accounts for the natural emergence of new kinds of motivational processes, the emergence of new forms of action selection. This holds both for phylogeny and for ontogeny. I illustrate this with an example of the emergence of something like curiosity and aesthetic motivation.[15]

There will be multiple influences on the activities of the central nervous system, but it also has endogenous tendencies that will be manifested over time and may be paramount in their influence at particular times when other modulatory influences, such as hunger, are quiescent. Consider, for example, the joint outcome of (1) system processes do not cease, (2) learning stabilizes successful forms of interaction, and (3) anticipations of uncertainty resolution are successful emotional interactions. Over time, this will tend to produce tendencies, when other influences are not dominant, to engage in activities of sorts that involve anticipations of successful emotional interactions. But what are those?

Successful emotional interactions are those that encounter uncertainty—novelty, complexity—with an anticipation of being able to resolve that uncertainty. So, a kind of activity that anticipates such uncertainty with resolution will engage something that is of sufficient novelty or complexity to elicit uncertainty, but of a sort for which the organism has learned it can generally anticipate successful resolution. Encountering such uncertainty and then resolving it, however, generally involves learning how to resolve it, at least in this instance.

Thus the joint effect of the three principles is that the organism will seek kinds of interactions that it has not mastered but that it has learned that it has a reasonable expectation of being able to master. Various manifestations of this motivational tendency are called curiosity, mastery motivation, competence motivation, or aesthetic motivation. Finally, such intrinsic motivations—intrinsic to the activity of exploring the object or phenomenon—can be centrally involved in discovering or creating new approaches and new solutions, that is, in creativity itself (Collins & Amabile, 1999).[16]

---

[14] *The model, then, is consistent, for example, with the dynamic and developmental perspective of Griffiths (1999).*

[15] *The caveat is because such specific motivations, like motivation itself, do not have well-defined characters. So what I am proposing is in part a specification of what these notions mean, as well as an explication of their prior meaning.*

[16] *Note that* extrinsic *motivation emerges directly in this model in the action-selection properties of hierarchies of goals and, perhaps even more interesting, in hierarchies of goals* about *goals – in which the* aboutness *requires a move up the hierarchy of knowing levels (Bickhard & Christopher, 1994; Campbell & Bickhard, 1986; Christopher & Bickhard, 1994).*

In this model, such motivations emerge in the interrelationships between activity, learning and emotions; there is no need to posit separate motivational systems or drives. This point is in addition to the more general one that motivation is an aspect of the activity of an interactive system, not a component of it.

Conclusion

Cognition and motivation do not constitute distinct subsystems of psychological processes. Instead, they are aspects of one underlying ontology of interactive systems. Such a model carries forward the basic process commitments that are urged on psychological studies by both historical and metaphysical considerations, accommodates the interactive-process model of the nature of representation and cognition, and accounts for higher-order motivation as emergents of the interactions between processes of knowing, learning and emotions.

References

Bickhard, M. H. (1992a). Piaget on variation and selection Models: Structuralism, logical necessity, and interactivism. In L. Smith (Ed.), *Jean Piaget: Critical assessments* (pp. 388-434). London: Routledge.

Bickhard, M. H. (1992b). 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, NJ: Erlbaum.

Bickhard, M. H. (1993). Representational content in humans and machines. *Journal of Experimental and Theoretical Artificial Intelligence*, *5*, 285-333.

Bickhard, M. H. (1997a). Is cognition an autonomous subsystem? In S. O'Nuallain, P. McKevitt, & E. MacAogain (Eds.), *Two sciences of mind* (pp. 115-131). Amsterdam: John Benjamins.

Bickhard, M. H. (1997b). Piaget and active cognition. *Human Development*, *40*, 238-244.

Bickhard, M. H. (2000a). Emergence. In P. B. Andersen, C. Emmeche, N. O. Finnemann, & P. V. Christiansen (Eds.), *Downward causation* (pp. 322-348). Aarhus, Denmark: University of Aarhus Press.

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

Bickhard, M. H. (2000c). Autonomy, function, and representation. *Communication and Cognition—Artificial Intelligence*, *17*(3-4), 111-131.

Bickhard, M. H. (2001). Why children don't have to solve the frame problems: cognitive representations are not encodings. *Developmental Review*, *21*, 224-262.

Bickhard, M. H. (2003). *The whole person: Toward a naturalism of persons—Contributions to an ontological psychology*. Manuscript in preparation.

Bickhard, M. H. (in press). The dynamic emergence of representation. In H. Clapin, P. Staines, & P. Slezak (Eds.), *Representation in mind: New approaches to mental representation*. Westport, CT: Praeger.

Bickhard, M. H., & Campbell, R. L. (1989). Interactivism and genetic epistemology. *Archives de Psychologie*, *57*(221), 99-121.

Bickhard, M. H., & Christopher, J. C. (1994). The influence of early experience on personality development. *New Ideas in Psychology*, *12*(3), 229-252.

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.

Bickhard, M. H., & Terveen, L. (1995). *Foundational issues in artificial intelligence and cognitive science: Impasse and solution*. Amsterdam: Elsevier Scientific.

Brown, H. R., & Harré, R. (1988). *Philosophical foundations of quantum field theory*. Oxford: Oxford University Press.

Campbell, D. T. (1974). Evolutionary epistemology. In P. A. Schilpp (Ed.), *The philosophy of Karl Popper* (pp. 413-463). La Salle, IL: Open Court.

Campbell, R. L., & Bickhard, M. H. (1986). *Knowing levels and developmental stages: Contributions to human development*. Basel, Switzerland: Karger.

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

Cao, T. Y. (1999). *Conceptual foundations of quantum field theory*. Cambridge: University of Cambridge Press.

Carlson, N. R. (2000). *Physiology of Behavior* (7th ed.). Boston: Allyn & Bacon.

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

Christopher, J. C., & Bickhard, M. H. (1994). The persistence of basic mistakes: Re-exploring psychopathology in individual psychology. *Journal of Individual Psychology*, *50*, 223-231.

Collins, M. A., & Amabile, T. (1999). Motivation and creativity. In R. J. Sternberg (Ed.), *Handbook of creativity* (pp. 297-312). New York: Cambridge University Press.

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

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

Ekman, P., & Davidson, R. J. (1994). *The nature of emotion*. Oxford: Oxford University Press.

Fodor, J. A. (1975). *The language of thought*. New York: Crowell.

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

Fodor, J. A. (1991). Replies. In B. Loewer & G. Rey (Eds.), *Meaning in mind: Fodor and his critics* (pp. 255-319). Oxford: Blackwell.

Fodor, J. A. (1998). *Concepts: Where cognitive science went wrong*. Oxford: Oxford University Press.

Frijda, N. H. (1986). *The emotions*. Cambridge: Cambridge University Press.

Gill, M. L. (1989). *Aristotle on substance: The paradox of unity*. Princeton, NJ: Princeton University Press.

Griffiths, P. (1997). *What emotions really are: the problem of psychological categories*. Chicago: University of Chicago Press.

Griffiths, P. (1999). Author's response. *Metascience*, *8*(1), 49-62.

Huggett, N. (2000). Philosophical foundations of quantum field theory. *British Journal for the Philosophy of Science*, *51*(Supp.), 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. (1993). *Supervenience and mind*. Cambridge: Cambridge University Press.

Kuhn, T. (1970). *The structure of scientific revolutions* (2nd ed.). Chicago: University of Chicago Press.

Lazarus, R. S. (1991). *Emotion and adaptation*. Oxford: Oxford University Press.

Levine, A., & Bickhard, M. H. (1999). Concepts: Where Fodor went wrong. *Philosophical Psychology*, *12*(1), 5-23.

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

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

Mook, D. G. (1996). *Motivation: The organization of action* (2nd ed.). New York: W. W. Norton.

Oatley, K. (1992). *Best laid schemes: The psychology of emotions*. Cambridge: Cambridge University Press.

Piaget, J. (1954). *The construction of reality in the child*. New York: Basic Books.

Piaget, J. (1970). *Genetic epistemology*. New York: Columbia.

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. I. Foundations*. Cambridge: Cambridge University Press.

Weinberg, S. (1996). *The quantum theory of fields. Vol. II. Modern applications*. Cambridge: Cambridge University Press.

Weinberg, S. (2000). *The quantum theory of fields. Vol. III. Supersymmetry*. Cambridge: Cambridge University Press.