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INTERACTIVISM

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The historical core of interactivism is a model of the nature of representing and representation. This model differs from alternatives in at least two interrelated ways: (1) it offers a dynamic, pragmatic, future-oriented, model of representation, in contrast to most alternatives, with far-ranging consequences for phenomena that involve representation, such as perception, language, rationality, learning, memory, motivation, emotions, consciousness, and sociality; and (2) it involves assumptions and positions regarding underlying metaphysical issues, such as normativity, emergence, process metaphysics, and naturalism, that also have ramified consequences and deep historical roots. I will focus, in this chapter, primarily on the model of representation.

Primitive representation

The evolution of complex animals required solving a general problem for agents: agents interact with their worlds, and agents must therefore select which interactions to engage in. I argue that representing, and later representations, emerged in the solutions to this problem. In simple animals (inter)action selection could be itself relatively simple, such as a triggering of action upon detection of sufficient triggering conditions. A bacterium that finds itself swimming down a sugar gradient, for example, will trigger tumbling for a moment in place of swimming; if it is swimming up a sugar gradient, it will tend to keep swimming. In more complex agents, however, the task of interaction selection begins to split into two related parts: (1) indications of what interactions are currently possible; and (2) selection among those possible of the "best" interaction relative to current goals and other internal states. A frog, for example, might have two flies that it could flick its tongue at in an attempt to eat, also a worm, and still further the shadow of a hawk flying overhead that invites jumping into the water. The frog must select among multiple possibilities, and it must keep some ongoing functional account of what those possibilities are. According to the interactivist model, representation originates in such indications of interaction possibilities, and the shift from triggering to selection among possibilities begins the evolution toward more complex (and more familiar) kinds of representation.[1]

Intentionality

Even in these simple versions, however, we have the emergence of a primitive intentionality: truth value and aboutness. Indications that some (type of) interaction is possible in the current situation might be true or might be false. Such an indication is a kind of dynamic predication concerning the current situation: this is one of those situations in which this (type of) interaction is possible. That dynamic predication can be true of the current situation or it can be false: this is one aspect of the emergence of truth value. Furthermore, if an indicated interaction is engaged and fails to proceed as indicated, it is not only false, it is falsified for the organism itself. Such system- (organism-) detectable error is of central importance, and will be addressed again later.

Some situations will realize conditions sufficient for an interaction type to proceed as "anticipated," and some will not. Some sufficient set of such interaction-supporting conditions is presupposed about the current situation in any indication that the interaction type is possible in that situation. The predication that an interaction type is possible in a situation constitutes a predication that some set of sufficient conditions hold in that situation. These sufficient conditions are presupposed. They are implicit, not explicit. They are the *content* that is presupposed *about* the situation, about the current environment.[2] They constitute what is true about the environment if the interaction-indication is correct.[3]

More complex representation

Resources

Functional indications of interaction potentialities possess two crucial characteristics of intentionality, but they don't look much like familiar representations. Nevertheless, we already have the beginnings of the resources that account for more complex representation and for the evolution of such more complex representation. The first part of these resources is the split already mentioned between indications of interaction potentialities and selections between such potentialities. In particular, the frog example is, among other things, an example of the sense in which interactive potentialities can branch into multiple possibilities.

The next resource arises from the point that the setting up of such indications requires that the organism have appropriate sensitivities to the environment, that the organism be able to differentiate environments in which it is appropriate to set up various interaction potentiality indications from environments in which it is not appropriate. That is, setting up interaction indications must be conditional.

Differentiation

Such conditions most generally arise in interactive differentiations: an interaction with the environment will proceed in part in accordance with the functional organization of the system engaging in the interaction, and in part in accordance with the environment being interacted with. Internal flows of such interaction, therefore, including culminating internal states of such interactions, can serve to differentiate types of environments from each other. If the interaction yields internal outcome A, say, rather than B, then the organism is in an A-type environment. Note that there is nothing in such an interaction to represent what constitutes an A-type environment: it is simply differentiated from B-types (and perhaps other possibilities). But the organism may learn, or have already innate, that A-type environments are a kind of environment in which it is possible to flick one's tongue a certain way and eat, while B-type environments permit, perhaps, a different sort of tongue flicking and eating. The outcomes of past interactions, then, serve the differentiating function that is necessary to successfully set up further indications of interactive potentiality. Whatever kinds of environments that happen to yield internal outcomes of A will, in this scenario, evoke indications of particular sorts of tongue flicking, and eating. For the frog, those kinds of environments will, hopefully, mostly be those that contain a fly with a certain position and direction. Note, however, that this requirement that A-type environments be fly-in-certain-circumstances environments is *factual* requirement on the frog's success. It is not something that the frog needs to able to represent for itself. So long as the conditions for setting up tongue flicking indications are *factually* appropriately sensitive to actual environments, the frog can survive. More will be said about such differentiations later; for now, what is crucial is the recognition that interaction indications are *conditional*.

Furthermore, those conditionalities are present even if the conditions per se are not satisfied. It is a property of the way in which the frog functions that, if a differentiation *were* to yield an A internal outcome, then an indication of the potentiality of tongue flicking and eating *would* be set up. And this conditionality is a fact about the functional organization of the frog, even when there is no support for an A-type differentiation present.

Indications of interaction potentialities, then, can branch and they are conditional. Their conditionality yields the possibility, if the organism is sufficiently complex in the right kinds of ways, that interaction indications can iterate. They can iterate in the sense that one interaction may yield the conditions under which another potentiality becomes indicated. Interaction X may yield the possibility for interaction Y, which, in turn, may yield the possibility of interaction Z.

Situation knowledge and apperception

In more complex organisms, such indications may branch and iterate into vast webs of organizations of conditional indications of interactive potentiality. This web is the basic resource for complex representation. Such a web constitutes the organism's *situation knowledge*: knowledge of the potentialities constituting the current situation. A web of any complexity will of necessity be ongoingly changing, due to processes in the environment, new interactions and differentiations, and just from the passage of time: the environment is not, in general, static. The processes of creating, maintaining, and updating situation knowledge are those of *apperception*.

Objects

As an example of how a situation knowledge web can account for more familiar forms of representation, consider a child's toy block. The block offers many interactive potentialities, of visual scans, manipulations, dropping, and so on, that can form a sub-web within the overall situation knowledge. These potentialities, furthermore, are all reachable from each other: e.g., any visual scan is reachable from any other via, perhaps, one or more intermediate manipulations of the block to bring the side into view. Still further, this sub-web of internally mutually reachable interactive potentialities is invariant under a large class of other interactions and changes that can take place. If the child leaves the room, or puts the block in the toy box, the sub-web is still reachable via the requisite intermediaries of going back into the room or opening the toy box. It is not invariant under all possible changes, however: crushing or burning the block destroys the interactive possibilities. In this general manner, the situation knowledge web can account for representations of manipulable objects.[4] Other complex representations, such as concepts, particulars, ideals, and so on, can similarly be modeled within situation knowledge.[5]

Some properties of representation

The interactivist model of representation can account for the emergence of truth value, content, and complex representations, such as of objects. There are a number of additional properties that follow from the interactivist account, some familiar, but some less familiar.

Embodiment

Recent discussions have emphasized several properties that follow directly from the interactivist model. Representation, on this account, is inherently embodied: only an embodied agent can interact with its environment. It is naturally situated in that environment, and its orientations to the environment are inherently indexical and deictic, with reference to the agent's possible actions and orientations.

Implicitness and modality

The implicitness of content has already been mentioned. This is in strong contrast to most models, for which content must be explicit if the representation is to exist at all. Another related property is that interactive content is inherently modal: it is of interaction *potentialities*. This is in contrast to focusing on representations of past or present actualities, with modality, if addressed at all, being added on with ad-hoc supplement.

Evolutionary epistemology

An action or interaction-based model forces a constructivism. It may be tempting to consider that representations are impressed into a passive mind like a signet ring into wax, or light transduced into unconscious propositions, or longer term inductive scratchings into the wax of the mind. But, if representation is in fact emergent in *interaction* systems, there is no temptation to assume that the environment can impress a competent interactive organization into a passive mind. Representation must be constructed.

Furthermore, if such constructions are not prescient, then they must be tried out, and selected out if they fail. There must be a variation and selection process: the interactive model forces an *evolutionary epistemology*.

In more complex organisms, this constructivism will be recursive in the sense that future constructions can make use of past constructions as units or foci of variation. In humans, at least, the processes of construction, not just what is constructed – learning and development – are themselves (recursively) constructed. Learning is the constructive process *per se*, while, for any recursive constructivism, the resources of past constructions introduce a historicity (and hysteresis) into possible trajectories of further construction that constitutes developmental constraints and enablings.

Emergent

Still further, representation is *emergent* in the constructions of interactive organization. Interactive organization that involves anticipations of what is or would be possible under indicated differentiation conditions constitutes representation, but it is constructed out of functional, control system organization that is not itself representational. Representation is emergent out of nonrepresentational phenomena.

Recognizing the possibility of emergent representation eliminates arguments for the *necessity* of innateness (such arguments fail anyway in that, if evolution can create representation, there is no argument offered why learning and development could not similarly create emergent representation). Further, if representation is emergent, the possibility is opened of ongoing nonrepresentational mental dynamics out of which representations emerge as a kind of generative foam, perhaps most of which fade out of existence, but some of which – those that are supported by or satisfy other considerations, perhaps – are stabilized sufficiently to participate in and influence further processes of thought. Such a dynamic of representationally emergent constraint satisfaction is utterly contrary to anything in the current literature, and yet fits the phenomenology of thought much better than alternatives.[6]

What about input processing?

The interactive, future-oriented modal character of representation, according to the interactive model, is diametrically opposite to standard models, which construe, for example, perception as beginning with the encoding of sensory inputs. Indeed, every introductory text in physiological psychology contains multiple chapters on "sensory encoding." It would seem to be the case, then, that at least some basic representation is not of the interactive kind. If that is *not* so – if all representation *is* interactive in nature – then the question arises of how the phenomena of, for example, frequency and line encoding discussed in such texts can be accounted for within the interactive framework?

The basis for the answer to this question has already been introduced. All agents must have differentiating contact with their environments in order to be able to appropriately set up indications of further interaction potentialities. Such differentiations are, in their most general form, full interactions in which the internal flow of the interactions and the internal outcomes of the interactions serve to differentiate types of environments encountered in those interactions. In general, *any* interaction that has concluded – that has already happened – can serve as the basis for such differentiation and, therefore, for apperception regarding situation knowledge. A limit case of such differentiating interaction, however, is that with null outputs: pure passive input processing. An input processing "interaction" can serve to differentiate in virtue of its internal outcome just as well as a full interaction. And it is such passive input processing differentiations that are called sensory encoding when they take place in physiologically specialized neural subsystems.

Sensory "encoding," then, is the input aspect of interactions that differentiate environments: frequency and line differences are differentiators. They constitute the necessary *contact* with the environment for appropriate orientation to the future. They do not, however – contrary to standard interpretation and to the standard meaning of "encoding" – constitute representations of what they differentiate. They do not constitute *content*.[7]

Contact and content

This distinction between contact and content is not familiar. It is not familiar because most models, especially information semantics and related approaches, equate the two. Whatever the differentiating contact is in fact with in the environment is taken to be what is represented by the differentiating internal states and processes. The (factual) *contact* is taken to be the (normative) *content* of the differentiating internal phenomena: the differentiation is taken to be a representation. This is one of the powerful sources, especially regarding perception, for the intuitions underlying standard models of representation. The assumption is made that a differentiating contact *encodes* what the contact is with.

Troubles with encodingism

Versions of this assumption are so common that I have come to call the assumption that all representation is encoding *encodingism*. The point is not that encodings do not exist, but that, when examined carefully, encodings are always and necessarily derivative representations – they are always stand-ins for already available representations.

Encodings, therefore, cannot serve any primary epistemic functions: they cannot be the ground of, for example, perception.

Consider "..." encoding *s* in Morse code. That encoding relationship certainly exists, and it is quite useful in that, e.g., "..." can be sent over telegraph wires while *s* cannot. But the encoding relation only exists for those who already represent the dot patterns, the characters, and the relationships among them. All relevant representations must already exist and be available in order for the encoding relation to exist. The encoding changes the form of representation by standing-in for some other representation, and such changes in form and other forms of stand-in can be useful, but encodings do not provide new representation.

If the conventionality of this example is troubling, consider the sense in which the neutrino count in some mine encodes properties of fusion processes in the sun. Here the encoding relationship is based on strictly natural phenomena and relations among them, but it is still the case that such encoding relationship itself exists only for those who already represent the neutrino-count process, the fusion process, and the relationships between them. Again, a natural information-based encoding relationship can enable our coming to know more about fusion in the sun without having to directly access that fusion, but it can do so only for those who already have all of the relevant representations.

In general, representation is held to be constituted by some favored special kind of relationship between the representation and that which it represents. This might be an informational relationship (in the strictly factual sense of co-variation, for example), or a causal relationship, or a nomological relationship, or a structural relationship. The favored kind of relationship is taken to constitute an encoding representational relationship. There is a large family of problems with any such approach – I will outline a few of them, but focus on one in particular.

Unbounded correspondences

For any particular instance of any one of these kinds of relationships, there are an unbounded number of additional instances, and it is not clear which one is to be taken as the "representational" instance. A causal relationship between activities in the retina and a table, for example, is accompanied by causal relationships with the light, with the quantum activities in the surface of the table, with the table a minute ago, with the trees out of which the table was constructed, with the fusion processes in the sun that fueled those trees, and so on, extending back several billion years. Which one is representational? And how does the organism determine which one is representational? And, however, it might be determined, how does the organism represent the favored one – clearly the relational instance per se cannot suffice, because it is at minimum ambiguous within an unbounded set. As before, the organism has to already have the crucial representation(s) in order for any kind of encoding to exist for that organism.

The copy argument

Piaget has an argument against any copy model of representation that provides a different aspect of these circularities: if our representations of the world are copies of the world, we would have to already know how the world is in order to construct our copies of it. Similarly, if we have an internal state or process that is in an informational relationship with something in the world, how does the organism determine that this state or process is in *any* informational relationship, and how does the organism determine what those informational relationships are with (there will be an unbounded number of them), how does the organism determine which of those is the "representational" instance, and how does the organism determine what that particular informational relationship is with? The same circularity as before.

Stand-ins

Because encodings are stand-ins, they cannot generate emergent representation – they must borrow their representational content. So, if *all* representations were encodings, then there would be nothing to borrow content from, so no representations could exist at all. Representation did not exist a dozen or more billions year ago, and it does now, so representation has to have emerged. Any model that renders such emergence impossible is thereby refuted. So, if arguments for innatism, for example, on the basis that it is not possible for learning or development to generate emergent new representations were *a priori* sound, then representation would simply be impossible.

Representational error

A crucial problem that highlights the confounding of representational models by normative considerations is that of accounting for the possibility of representational error. If the favored representation-constituting relationship exists, then the representation exists, and it is correct. But if the favored representation-constituting relationship does not exist, then the representation does not exist. Unfortunately, there is a third possibility that must be accounted for, but there are no remaining resources to deploy in any such account: the possibility is that of the representation existing but being false. There has been a minor industry in the literature for a couple of decades attempting to address this problem, but without success. At best, they can account for some external observer of the organism and its environment, who somehow knows what the organism's internal states are supposed to represent (knows their content), and can compare that with the "real" world to determine if the content fits the actual represented. In general, they don't accomplish even this much, but, even if they did, this account would leave the representations of the external observer unaccounted for – the external observer's representations have to be capable of truth and falsity too.

System-detectable representational error

There is an even stronger version of the error problem that is simply not addressed at all in the literature: the possibility of system-, or organism-, detectable error – that is, not just error in some God's eye view, but error that can be detected by the organism itself. This may at first seem to be not directly relevant – perhaps too strong a criterion that should be postponed 'till further progress has been made. But, if organism-detectable error is not possible, then error-guided behavior and learning are not possible. We know that error-guided behavior and learning occur, so any model that cannot account for system-detectable error is thereby refuted.

Furthermore, the problem of system-detectable error is the core of the radical skeptical argument: you cannot determine the correctness or incorrectness of your own representations, so the argument goes, because you would have to step outside of yourself (become your own external observer) to compare your representations with the actual world, and you cannot do that. This argument has been around for a very long time and has remained unrefuted to the point that it is most often ignored as unsolvable, so why bother. But, again, there has to be something wrong with the argument, because, if its conclusion were correct, error-guided behavior and learning would not be possible.

The interactive model of representation accounts for both the possibility of error and the possibility of system-detectable error in fairly simple ways: the functional anticipations or indications that constitute representation can easily exist but nevertheless be in error, and furthermore if an indicated interaction is engaged and it fails to proceed as indicated, then it is false and it is falsified in a manner functionally accessible by and for the organism itself. The key difference is that (interactive) representation is future oriented and can be false about the future and be discovered to be false about that future. I will use this criterion of system-detectable error as a universal perspective within which to show that the major alternative approaches to representation in the literature cannot possibly be correct.

Representation still resists naturalism

Millikan

According to the interactivist model, normativity emerges most primitively in biological function, and representation emerges in the serving of particular functions. In this macro-architecture, the interactivist model is similar to Millikan's etiological model (1984, 1993, 2004, 2005), but there are wide divergences at more detailed levels. I will outline a few of them.

Having a biological function, according to Millikan's model, is constituted in having the right kind of evolutionary history of selections. Kidneys have the function of filtering blood because that's what ancestral kidneys were selected for doing. This is a powerful model with strong appeal, though it does have some counterintuitive consequences. Consider, for example, the thought experiment of Millikan's lion that pops into existence in the corner via a coalescence of molecules, and that is, by assumption, molecule-by-molecule identical to a lion in the zoo. Or, for a less science-fictional example, consider the first time that something emerges in evolution that is useful to the organism that it is a part of.

The zoo lion has organs that have the right evolutionary history and, therefore, have functions; the lion in the corner, even though identical in its current state, has organs with *no* evolutionary history and, therefore, no function. Similarly, the brand new evolutionary emergent has no evolutionary history and, therefore, no function, while a sufficiently generationally removed descendent, even if identical in other respects, will (or may) have the right evolutionary history and, therefore, will have a function. These kinds of examples are acknowledged as counterintuitive but are considered to be quite acceptable, given the overall power of the model.

But what is not often remarked is that the lion in the corner is identical in state to the lion in the zoo, therefore the two lions are dynamically, causally, identical, yet one has functions while the other does not. Similarly, the fresh evolutionary emergent might be identical in causal dynamics to its descendent, yet one has functions while the other does not. In such cases we see that having or not having etiological function has no consequence for causality: etiological function is, causally, epiphenomenal.

Consequently, representation based on etiological function is causally epiphenomenal. Etiological history may explain etiology, but it is otherwise irrelevant to causality. This constitutes a failure of naturalism.[8]

Even if we overlook this problem, however, the etiological model faces, among other things, the system-detectable error problem. Representation is constituted as a kind of function, and function is constituted in having the right kind of evolutionary history. But no organism has access to its relevant evolutionary history, therefore no organism has access to the contents of its own representations.

And even if it did, system-detectable error would require that the organism compare that content with what was currently being represented, and that poses the representational problem all over again: circularity. The radical skeptical argument applies in full force: system-detectable error is not possible on this account, therefore error-guided behavior and learning are not possible.

Dretske

Dretske's model (1988) is also an etiological model, though the relevant etiology is a learning history, not an evolutionary history. Nevertheless, the same point about causal epiphenomenality applies: something *constituted* in the past history (not just explained by that past history) cannot have causal consequences for the present – only current state is causally efficacious.

Also similarly, organisms do not in general have access to their own learning history (certainly not simpler organisms nor infants, for example), and therefore do not have access to their own representational contents. And, as before, even if they did, system-detectable error would require that they compare those contents with what is currently being represented and we yet again encounter the basic circularity of correspondence models of representation.

Fodor

Fodor's model of representation (1987, 1990a, b, 1998, 2003) is an explicitly informational semantics model: representation is constituted in having the right kind of informational relationship with what is being represented. For Fodor, this right kind of relationship is a nomological relationship, with a few additional criteria.

Of particular importance for current purposes is Fodor's attempt to address the problem of representational error. He points out that cases of incorrect representation are derivative from cases of correct representation in an asymmetric manner. A representation of a cow, for example, that is *incorrectly* applied to what is in fact a horse (perhaps on a dark night), is dependent on the possibility of the cow representation being *correctly* applied to cows, but the reverse dependency does not hold: The cow representation could apply to cows perfectly well even if it were never incorrectly applied to horses.

This asymmetric dependency criterion has counterexamples, even as a criterion for representational error *per se*. A poison molecule, for example, that mimics a neurotransmitter and docks on the same receptor molecule as the neurotransmitter molecule manifests the same asymmetric dependencies as the "cow" and "horse" example, but there is no representation at all. At best, the asymmetric dependency criterion captures a property of functional error, not representation.

Even if it did capture representational error, however, it still does not even address system-detectable representational error. As before, no organism has access to its relevant asymmetric dependencies among classes of counterfactual possibilities of correct and incorrect applications, therefore, no organism has access to its own contents. And, also as before, even if it did, system-detectable error would require that such contents be compared with what is being currently represented, and that poses the representation problem yet again: circularity yet again.

The symbol system hypothesis

Cognitive science was long dominated by the symbol system hypothesis. This hypothesis held that symbols represented via some kind of "designation" relationship, usually relatively unspecified. Whatever the special favored relationship – pointer, transduction, structural isomorphism, etc. – this framework does not have any response to the problem of representational error, and certainly none to the problem of system-detectable representational error.

Connectionism

Connectionism holds that representation is constituted in vectors of activations of nodes, usually in connectionist nets that have been trained to be evoked in response to favored classes of input patterns. There is certainly important power available in the properties of distributedness and trainability in these models, but, with regard to representation per se, a connectionist activation vector "representation" is "just" a trained transduction, and provides no new resources for addressing genuine representational issues.

Dynamics

Connectionism was overtaken as the frontier of cognitive science in the 1990s by various dynamic and agentive approaches. These were advances in multiple ways, but the debates concerning representation generally fell into either a pro- or an anti-representationalist camp, but with the notions of representation at issue being the same familiar correspondence-encoding models as before. There was no progress regarding such issues as error or system-detectable error – with respect to normativity.

Convergences

The interactivist model is clearly a kind of dynamic model. In fact, it is rooted in a process metaphysics at the most fundamental level. But the interactivist model introduces notions of normativity, agency, and an agent-interaction-based model of representation, among others – issues that are not generally addressed within dynamic approaches.[9] Issues of error-guided behavior and learning, among others, require addressing such phenomena of normative intentionality.

In its interaction framework, the interactivist model makes strong connections with Piaget and Gibson as well as the pragmatist philosophers – especially Peirce and Dewey – and the pragmatically oriented existentialists, such as (early) Heidegger and Merleau-Ponty. These movements away from the substance-and-particle frameworks of antiquity are still historically very recent, and the relevant conceptual and theoretical spaces still only sparsely explored. The interactivist model has developed within this overall framework, thus the convergences and borrowings. The interactivist model of interactive *representation*, with truth value and aboutness (intentionality), is among its *unique* developments within that framework.

Conclusion

Representation emerges as part of the solution to the problem of interaction guidance and selection. It is a necessary aspect of the dynamics of agents. Unlike standard past-oriented correspondence-encoding models, it is future-oriented, action-based, modal, and explains the possibilities of representational error and system-detectable representational error in simple and natural ways. It grounds more complex forms of representation and cognition with resources that emerge naturally as primitive representation evolves.

Notes

1. This evolution of representation is a natural progression in the evolution of agents, *including the evolution of artificial agents*: robots.

2. In being presupposed and implicit, such content is unbounded: there is no explicit bound on what such conditions might be. Any attempt to render such unbounded ranges explicitly, therefore, will encounter the inherent problem that there is no bound on what or how many explicit renderings are required to exhaust the implicit content. Elsewhere I argue that this is the source of the frame problems.
3. It should be noted that this model of truth value and content depends on the normative notion of "indication" or "anticipation." Such normativity must itself be accounted for. The interactivist model shows that such normative properties can be emergent as particular kinds of normative function (function in the service of interaction selection). Normative function, in turn, is emergent in particular kinds of far-from-thermodynamic-equilibrium processes. Such emergence must be a genuine metaphysical emergence, and, the argument continues, metaphysical emergence requires abandoning the substance and particle metaphysics that have descended from Parmenides and his successors in favor of a process metaphysics. These issues are addressed elsewhere.
4. This is basically Piaget's model of the representation of manipulable objects stated in interactivist terms. It is possible to borrow such models from Piaget because both approaches are action-based, pragmatic approaches. Piaget's model and interactivism, however, diverge in important respects.
5. Some representational phenomena require reflection, which, in turn, requires significant additional architecture.
6. Note that the foam of emergents would constitute a source of variable candidates, while the constraints would constitute selection criteria for those candidates: the overall dynamic would constitute an internal evolutionary epistemology.
7. Perception, in the interactive model, is constituted by interactions that are undertaken primarily for the sake of their apperceptive consequences rather than for the changes they might induce in the environment. This is especially the case for apperceptively oriented interactions involving physiologically specialized subsystems for such interactions: the classical sensory modalities. Perception in this sense can also accommodate non-specialized processes, such as reading X-rays or sonar. Perception involves passive input processing, but cannot be fully captured by passive models: perceiving is itself an active, ongoing interactive process and is much more akin to Gibson's model than to standard passive encoding models.
8. Note that if the etiological model of function were correct, it would violate Hume's argument that norms cannot be derived from facts – the argument that Kant, Hegel and the idealists, the logical positivists, and the Quinean "sciencists" alike have all accepted and based their work on. The interactive model of function faces the same apparent barrier: Hume's argument precludes the possibility of a naturalistic model of any kind of normativity. Hume's argument, however, is unsound. This point is developed elsewhere.
9. Note that any dynamic model of interactive agents will of necessity include a model of interaction guidance and selection and, therefore, of at least the primitive versions of interactive representation. This holds even if, as has been typical, there are explicit arguments *against* the inclusion or relevance of representation in the model in any of the classical correspondence encoding senses. That is, modeling agents requires modeling representation in the sense of phenomena with truth value and aboutness, whether or not any such vocabulary is used.

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Further reading

An interesting exchange between some commentators and critics, with Fodor's replies, can be found in B. Loewer and G. Rey, *Meaning in Mind: Fodor and His Critics* (Oxford: Blackwell, 1991). A good overview of Fodor's philosophy is M. J. Cain, *Fodor* (Oxford: Blackwell, 2002). The seminal work on evolutionary epistemology (though the idea is some years older) is D. T. Campbell, "Evolutionary Epistemology," in P. A. Schilpp (ed.), *The Philosophy of Karl Popper* (LaSalle, IL: Open Court, 1974), pp. 413–63. One (of many) of Piaget's classics, this one focuses the child's construction of reality, including that of objects: J. Piaget, *The Construction of Reality in the Child* (New York: Basic Books, 1954).

The following are suggestions for pursuing some of the connections between the interactivist model and various issues and domains in the broader literature. A detailed presentation of the early model of language and cognition is M. H. Bickhard, *Cognition, Convention, and Communication* (New York: Praeger, 1980). For the basic model of representation, including normative issues, and an extended critique of Fodor, see M. H. Bickhard, "Representational Content in Humans and Machines," *Journal of Experimental and Theoretical Artificial Intelligence* 5 (1993): 285–333. A brief introduction to the interactivist model of motivation and emotion is M. H. Bickhard, "Motivation and Emotion: An Interactive Process Model," in R. D. Ellis and N. Newton (eds), *The Caldron of Consciousness* (Amsterdam: J. Benjamins 2000), pp. 161–78. In this model, motivation and cognition are differing aspects of the same underlying system organization, as discussed in M. H. Bickhard, "An Integration of Motivation and Cognition," in L. Smith, C. Rogers, and P. Tomlinson (eds), *Development and Motivation: Joint Perspectives*, Monograph Series II (Leicester, UK: British Psychological Society, 2003) pp. 41–56. A model of metaphysical emergence based on process metaphysics, with applications to function and representation, is M. H. Bickhard, "Process and Emergence: Normative Function and Representation," *Axiomathes – An International Journal in Ontology and Cognitive Systems* 14 (2004): 135–69; originally published in J. Seibt (ed.), *Process Theories: Crossdisciplinary Studies in Dynamic Categories* (Dordrecht: Kluwer, 2003), pp. 121–55. On how the interactivist framework yields a model of emergent social ontology, and of persons as social-level emergents, see M. H. Bickhard, "The Social Ontology of Persons," in J. I. M. Carpendale and U. Muller (eds), *Social Interaction and the Development of Knowledge* (Mahwah, NJ: Erlbaum, 2004), pp. 111–32; "Are You Social? The Ontological and Developmental Emergence of the Person," in U. Müller, J. I. M. Carpendale, N. Budwig, and B. Sokol (eds), *Social Life and Social Knowledge* (New York: Taylor & Francis, 2008), pp. 17–42; and "Social Ontology as Convention," *Topoi* 27, no. 1–2 (2008): 139–49.

The model accounts for multiple phenomena of consciousness in M. H. Bickhard, "Consciousness and Reflective Consciousness," *Philosophical Psychology* 18, no. 2 (2005): 205–18. A basic outline of the developmental aspects of the interactivist model is found in R. L. Campbell and M. H. Bickhard, *Knowing Levels and Developmental Stages*, Contributions to Human Development (Basel, Switzerland: Karger, 1986). Issues of normativity are central to the development of children in M. H. Bickhard, "Developmental Normativity and Normative Development," in L. Smith and J. Voneche (eds), *Norms in Human Development* (Cambridge: Cambridge University Press, 2006), pp. 57–76. Later discussions of language and its properties are covered in M. H. Bickhard and R. L. Campbell, "Some Foundational Questions Concerning Language Studies: With a Focus on Categorial Grammars and Model Theoretic Possible Worlds Semantics," *Journal of Pragmatics* 17, no. 5–6 (1992): 401–33; and "Intrinsic Constraints on Language: Grammar and Hermeneutics," *Journal of Pragmatics* 23 (1995): 541–54. The model has fundamental convergences with James Gibson's model of perception, as well as some important divergences, as shown in H. M. Bickhard and D. M. Richie, *On the Nature of Representation: A Case Study of James Gibson's Theory of Perception* (New York: Praeger, 1983). The model has critical relevance to multiple positions, frameworks, and assumptions in the fields of artificial intelligence and cognitive science, as shown in M. H. Bickhard and L. Terveen, *Foundational Issues in Artificial Intelligence and Cognitive Science: Impasse and Solution* (Amsterdam: Elsevier, 1995). For a presentation of the central model of normative function, see W. D. Christensen and M. H. Bickhard, "The Process Dynamics of Normative Function," *Monist* 85, no. 1 (2002): 3–28.