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Piaget and Active Cognition

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Throughout Western history, the study of mind has been dominated by the assumption that the proper focus for understanding the mind is *consciousness*. Representation and cognition, in this classical view, are products of impressions into consciousness, or result from the processing of inputs into products that attain consciousness. Representation is assumed to consist in such mental elements that are in correspondence with what they represent, and thereby encode what they represent. The paradigm case is the processing of visual inputs that is assumed to yield a mental scene representing the objects in space and time from which light was reflected to generate the inputs.

This classical approach has encountered multitudinous difficulties, some of which are of ancient provenance and are still unsolved – and more continue to be discovered [Bickhard, 1993, 1996; Bickhard and Terveen, 1995]. For example, if we attempt to check a presumed representational correspondence to see if it is correct, we can only invoke that same representation again – any such test is circular. There is no independent way to gain epistemic access to the other end of presumed representational encodings to see if they are accurate. This and related skeptical arguments bedevil epistemology, and also have troubling implications for psychology and developmental psychology: if our account of representation does not permit the detection of representational error, then how can we account for error-guided behavior and error-guided learning and developmental processes?

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Late last century, Peirce challenged this framework of assumptions, and introduced *action* as an alternative locus for the study of the mind [Joas, 1993; Rosenthal, 1983]. Ultimately, of course, both consciousness and action (and many more processes) must be accounted for. The issue at hand is what the most perspicacious *general* framework is for the study of mind. One strong advantage of action as a framework is that it makes evolutionary continuities with other species no longer problematic in principle, while consciousness has classically seemed to produce a singular gulf between humans and simpler species.

This *pragmatist* approach has undergone many developments, but it is still very much a minority position. The general action or pragmatist orientation is represented in psychology most strongly by Jean Piaget – a primary line of influence is from Peirce and James to Baldwin to Piaget. Piaget studied cognition as it developmentally emerges in organizations of action and interaction, and generated the most coherent and encompassing model of development to be found.

An action focus integrates multiple properties of development in a natural way. For example, if representation is thought to be some sort of encoding correspondence between the mental representation and whatever it represents, it is tempting to assume that the represented object or property somehow impresses itself into the mind, or generates light that impresses itself into the mind, thereby creating those encodings via transduction (or something like transduction). But if representation is emergent in action systems, there is no temptation to think that an action system could be impressed into a passive mind. Systems for successfully interacting with something bear no particular structural relationship with that something, only interactive relationships; therefore, they cannot be created from passive contact. Systems for action and interaction must be *constructed*: an action focus forces a constructivism [Bickhard and Campbell, 1989].

In spite of the attractions and promise of Piaget's action-oriented model, his work was assimilated, with consequent severe distortions, into the empiricist traditions that dominate English and American psychology. Empiricism is one version of the classical framework that takes representation as fundamentally consisting of encoding correspondences. Piaget's pragmatist approach was not understood in American psychology. His work fell into increasing disfavor, largely because of the failure of empiricist interpretations of his views. Some of these interpretations were so badly distorted that Piaget ended up being criticized for positions he had never taken [Chapman, 1988; Lourenço and Machado, 1996].

During the 1970s, when (often ill-founded) anti-Piagetian claims were a primary career path. Piaget was continuing to develop his model in new and even more powerful ways. This last phase of Piaget's theorizing, however, has been mostly ignored through the 1980s and into the 90s because of the assumption that Piaget had already been refuted. Much of this work has only slowly been translated into English, and at times translated against the resistance of those who claimed that it was of no contemporary importance.

Barrouillet and Poirier offer a number of considerations counter to this standard 'wisdom'. They (1) outline a crucial aspect of Piaget's last version of his model (in terms of morphisms and categories); (2) demonstrate that it avoids some critical problems of earlier versions; (3) compare it favorably to some contemporary alternatives, and (4) demonstrate that it can account for a range of developmental phenomena in an integrated way. There is an irony and an egregious error of scholarship in Piaget having

been rejected on the basis of misinterpretations of (i.e., failures of accommodation to) his work, and Barrouillet and Poirier show that it may well have been an egregious scientific error as well.[1]

I strongly support Barrouillet and Poirier's advocacy of Piaget's orientation. There are deep and arguably fatal problems with the standard approaches to cognition, and they manifest themselves in errors of theory and errors of methodology. But the pragmatist, and Piagetian, alternative has yet to be understood well enough in English speaking realms to be able to be taken seriously. Developmental psychology, and psychology more broadly, would benefit greatly from a pragmatist/Piagetian broadening of horizons.

Within that pragmatist/Piagetian framework, however, there is much work still to be done. I do not think that Piaget got it quite right, and I think Barrouillet and Poirier have not gotten Piaget quite right. To address the latter point first: Barrouillet and Poirier contrast Piaget's morphisms and categories approach with his earlier work as reducing 'Piaget's past overemphasis on the subject's actions and operations at the expense of figurative aspects of thought (i.e., language and representation)'. I do not agree with the exclusivity of the contrast between action, on the one hand, and the figurative and representational, on the other, that is attributed to Piaget here. In particular, action seems to have remained central to Piaget's thinking – to figurative and representational cognition as much as to anything else:

> Assimilation, as incorporation of objects or facts of any sort whatsoever to schemes of action, constitutes the functional mechanism common to all knowledge at every level. In this conception, the term 'scheme' expresses what is repeatable in actions, actions being conceived in the broadest sense from perception (which is an activity) or sensorimotor behavior up to operations or conceptualization of the highest levels. ... assimilation is the source of correspondences [Piaget et al., 1992, p. 219].

Second, while I would agree that this later work of Piaget's involves more of an emphasis on exogenous factors in the constructive processes than was previously the case, I would offer two comments presenting a different interpretation of that shift:

(1) One of Piaget's long-standing motivating issues was the origin of knowledge of logical necessity. Necessity cannot be derived empirically – it has been a classical challenge from rationalists to empiricists – and Piaget found rationalism, especially in its innatist variety, equally unsatisfactory. He was seeking a 'third way', neither empiricist nor rationalist, and necessity was a primary point at which the issue was drawn. Within this framework, Piaget's emphasis on endogenous factors in development was natural: he thought that the emergences generated by equilibration provided that third way.

[1] Research based on anti-Piagetian motives has often been not only based on false interpretations of Piaget, but also has yielded methodological errors that seem to reflect naive empiricist conflations, such as 'If it is an object that the infant is seeing (factually), then the infant must be seeing an object (cognitively)'. *Perceptual* alternative hypotheses to the favored *cognitive* interpretations of results have frequently not been considered, and control conditions for them not used. That is, interpretations of results in terms of object-cognizing processes are assumed, while often readily available alternative interpretations in terms of simpler perceptual processes are ignored. See, for illustrations, Bogartz et al. [1977]; Haith [1997]. For a wealth of perceptual characteristics (and others) that have been ignored in much recent research (such as perceiving relationally rather than absolutely) see Stevenson [1972].

Piaget did not abandon his focus on necessity in his later work, but did expand the scope of his considerations to include a stronger emphasis on exogenous forms and objects of interaction. Relative to his primary concerns, however, it is not so clear to me that his earlier stronger emphasis on endogenous factors constituted an imbalance.

(2) The increased emphasis on exogenous factors does remove an imbalance with regard to some developmental issues, and the shift to a more procedural framework in Piaget's later work is a fundamental theoretical improvement for all issues [Inhelder and Piaget. 1979], but insofar as that shift to a stronger consideration of exogenous factors is manifested in a stronger consideration of *figurative representation*. I would argue that this move in Piaget's later work constitutes an error compounding an earlier error. In particular, Robert Campbell and I have argued that figurative knowledge carries vestigial commitments to the classical encoding conceptions of representation, and, therefore, is subject to all of the multitudinous errors and problems of that approach [Bickhard, 1992a, 1993, 1996; Bickhard and Campbell, 1989; Campbell and Bickhard, 1986]. (Furthermore, I have argued that it is an error to consider language to be fundamentally representational, or 'figurative', at all [see Bickhard, 1980, 1992b; Bickhard and Campbell, 1992; Bickhard and Terveen, 1995].) Instead of an increased emphasis, therefore, I would urge that figurative knowledge, at least as it is modeled, be *eliminated* from the theoretical framework in favor of an even more coherent action and interaction pragmatist approach.[2] Piaget's shift, in contrast, appears to be an error that compounds his earlier error of retaining encodingist flavored figurative knowledge in the earlier versions of his work.

Piaget's turn to category theory in his later work constitutes an extension of his earlier structuralism using much richer mathematical resources than had been available before. Category theory is sufficiently rich and productive, in fact, to provide an alternative to set theory as a foundation for all of mathematics [Lawvere, 1966; MacLane and Moerdijk, 1992]. Nevertheless, I am uneasy about this move, not with respect to category theory per se, but with respect to Piagetian structuralism. Piaget was always interested in the special properties of and relationships between form and function, and his structuralism is a manifestation of his interest in form. Emergent form and the properties that emerge with emergent form, in fact, were at the core of Piaget's 'third way' account of logical and mathematical necessity [Bickhard, 1992a: Moshman and Timmons, 1982; Smith, 1993]. Nevertheless, I do not think this approach worked for necessity [Bickhard, 1992a; Campbell and Bickhard, 1986], and I have strong misgivings about such a structuralism in general. Among other problems, it is quite difficult to account for the relationships between such atemporal structural forms and the actual

[2] In addition to the fatal philosphical problems with encodingist approaches, a figurative model encounters *additional* severe conceptual and empirical problems. Piaget was a sufficiently deep thinker to recognize these problems (most have not seen them at all), such as the extreme difficulty in accounting for perception of speed and duration within a model of ordinally organized perceptual snap-shots. Those problems simply disappear if an intrinsically temporal interactive model is adopted. Furthermore, the empirical evidence simply does not support the implications of such figurative models. Evidence shows, for example, that duration comparisons do *not* in fact involve the in-principle difficulties that a Piagetian figurative orientation would predict [Richie and Bickhard, 1988]. Within the Piagetian framework, acceleration comparisons should be even more impossible, yet even infants can make such comparisons [Ramalho, 1990].

actions out of which they are supposedly composed[3] [Bickhard, 1988; Inhelder and Piaget, 1979] – more generally, it is difficult to relate supposed atemporal mental structures to temporal processes, whether mental or behavioral processes. I would advocate a more through process metaphysics for the study of mind and development [Bickhard, 1993; Bickhard and Christopher, 1994; Bickhard and Terveen, 1995].

Dynamic systems theory and the explanatory notion of intrinsic constraints seem to provide the kinds of conceptual tools that Piaget needed [Bickhard, 1992b, c; Bickhard and Terveen, 1995; Campbell and Bickhard, 1986; Hooker, 1994, 1995, 1996], but they were not available at the time except as tools deeply embedded in mathematical physics, and Piaget did not have access to them. It is not clear, however, whether he would have been comfortable with a strict process metaphysics even if he had had access to such conceptual tools. Nevertheless, it is worth pointing out that much of the special power of category theory, as Piaget made use of it, derived from the sense in which category theory incorporated reflective abstraction into the formalism more than from the structural considerations per se [Piaget et al., 1992, p. xxi, 217]. In particular, category theory permits a careful account of Piaget's notion of 'operations on operations' that incorporates 'reflecting abstraction'.

With regard to class inclusion problems, it is reflective abstraction on the class inclusion relationship per se that permits the comprehension of one of the properties of that relationship: the necessity of subsets being less than or equal to inclusive sets in number [Campbell, 1991; Campbell and Bickhard, 1996]. With regard to arithmetic problems, it is reflective abstraction on operations on numerical states that permits the comprehension of numbers as operators to be composed (+n or –n) rather than only as states to be operated upon [Barrouillet and Poirier, 1997; Cooper, 1984, 1991]. From its inception, reflective abstraction became increasingly important in Piaget's thinking but remained distinct from his structuralist concerns per se for some time. The category theory framework, especially with its central concept of a morphism that captures and operates on underlying forms, permits an integration of reflective abstraction with considerations for structure: to be able to comprehend morphism relationships, underlying form must have already been reflectively abstracted from particular contents or states that might manifest that form. Again, however, I would suggest that it is the reflective abstraction per se that is of deepest importance here.

Barrouillet and Poirier have provided a major service in sketching a critical part of Piaget's last version of his model and showing that it not only corrects difficulties in earlier versions, but that it also accounts for developmental phenomena that few alternative models in the literature can even address. Simply stated, few models in contemporary developmental literature contain any notion or process akin to reflective abstraction [for a proposed model of the *process* of reflective abstraction, see Campbell and Bickhard, 1986], yet such reflection, in *some* form, is clearly profoundly involved in

[3] For example, what counts as an action? What are the boundaries between one action and another, or between an action type and a closely related type, or an action and a later instance of that action? And so on. There is a threat of a reification of action as a concept of behavioral process into a mental element of some unspecified sort that explains that action and that can be combined in various structural ways with other such 'actions' as mental elements. That is, there is the threat of the reification of description into explanation [Campbell and Bickhard, 1986].

thought and development. More broadly, Piaget's action focus and its theoretical and philosophical power is only dimly appreciated in contemporary psychological literature. There is still much to be learned from Piaget's work. Developmental psychology has shortchanged itself, and continues to do so, by its neglect of this work and the tradition which it represents. The field would benefit greatly from expanding its scope to genuinely engage this alternative perspective.

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References

Barrouillet, P., & Poirier, L. (1997). Comparing and transforming: An application of Piaget's morphism theory to the development of class inclusion and arithmetic problem solving. *Human Development 40*, 217–235.

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

Bickhard, M.H. (1988). The necessity of possibility and necessity: Review of Piaget's Possibility and Necessity. *Harvard Educational Review, 58*, 502–507.

Bickhard, M.H. (1992a). Piaget on variation and selection models: Structuralism, logical necessity, and interactivism. In L. Smith (Ed.), *Jean Piaget: Critical assessments. (Vol. 4)*. New York: Routledge. (Original work published 1988).

Bickhard, M.H. (1992b). How does the environment affect the person? In L.T. Winegar, & J. Valsiner (Eds.), *Children's development within social contexts: Metatheory and theory*. Hillsdale, NJ: Erlbaum.

Bickhard, M.H. (1992c). Myths of science: Misconceptions of science in contemporary psychology. *Theory and Psychology, 2*(3), 321–337.

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

Bickhard, M.H. (1996). Troubles with computationalism. In W. O'Donohue, & R.F. Kitchener (Eds.), *The philosophy of psychology*. London: Sage.

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

Bickhard, M.H., & Campbell, R.L. (1992). Some foundational questions concerning language studies: With a focus on categorial grammars and model theoretic possible worlds semantics. *Journal of Pragmatics, 17*(5/6), 401–433.

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., & Terveen, L. (1995). *Foundational issues in artificial intelligence and cognitive science: Impasse and solution*. New York: Elsevier Scientific.

Bogartz, R.S., Shinskey, J.L., & Speaker, C.J. (1997). Interpreting infant looking: The even set x event set design. *Developmental Psychology, 33* (3), 408–422.

Campbell, R.L. (1991). Does class inclusion have mathematical prerequisites? *Cognitive Development, 6*, 169–194.

Campbell, R.L., & Bickhard, M.H. (1986). *Knowing levels and developmental stages*. Contributions to Human Development. (Vol 16). Basel: Karger.

Chapman, M. (1988). *Constructive evolution: Origins and development of Piaget's thought*. Cambridge, UK: Cambridge University Press.

Cooper, R.G., Jr. (1984). Early number development: Exploring number space with addition and subtraction. In C. Sophian (Ed.), *Origins of cognitive skills*. Hillsdale, NJ: Erlbaum.

Cooper, R.G., Jr. (1991). The role of mathematical transformations and practice in mathematical development. In L.P. Steffe (Ed.), *Epistemological foundations of mathematical experience*. New York: Springer-Verlag.

Haith, M.M. (1997, April). Who put the cog in infant cognition: Is rich interpretation too costly? Paper presented at the Biennial meetings of the Society for Research in Child Development, Washington, DC.

Hooker, C.A. (1994). Piagetian psychology, biology, and evolutionary epistemology: A regulatory systems approach. *Biology and Philosophy, 9*, 197–244.

Hooker, C.A. (1995). *Reason, regulation and realism: Toward a naturalistic, regulatory systems theory of reason*. Albany: State University of New York Press.

Hooker, C.A. (1996). Toward a naturalised cognitive science. In R. Kitchener, & W. O'Donohue (Eds.), *Psychology and philosophy*. London: Sage.

Inhelder, B., & Piaget, J. (1979). Procédures et structures. *Archives de Psychologie, 47*, 165–176.

Joas, H. (1993). American Pragmatism and German thought: A history of misunderstandings. In H. Joas (Ed.), *Pragmatism and social theory*. Chicago: University of Chicago Press.
Lawvere, F.W. (1966). The category of categories as a foundation for mathematics. *Proceedings of the Conference on Categorial Algebra*. pp. 1–21, La Jolla, 1965. New York: Springer.
Lourenço, O., & Machado, A. (1996). In defense of Piaget's theory: A reply to 10 common criticisms. *Psychological Review, 103*(1), 143–164.
MacLane, S., & Moerdijk, I. (1992). *Sheaves in geometry and logic*. New York: Springer-Verlag.
Moshman, D., & Timmons, M. (1982). The construction of logical necessity. *Human Development, 25*, 309–323.
Piaget, J., Henriques, G., & Ascher, E. (1992). *Morphisms and categories. Comparing and transforming*. Hillsdale, NJ: Erlbaum.
Ramalho, M.G. (1990). *Infant's perception of constant and varying speed motion*. Unpublished Doctoral Dissertation, University of Texas at Austin.
Richie, D.M., & Bickhard, M.H. (1988). The ability to perceive duration: Its relation to the development of the logical concept of time. *Developmental Psychology, 24*, 318–323.
Rosenthal, S.B. (1983). Meaning as habit: Some systematic implications of Peirce's pragmatism. In E. Freeman (Ed.), *The relevance of Charles Peirce*. La Salle, IL: Monist.
Smith, L.A. (1993). *Necessary knowledge: Piagetian perspectives on constructivism*. Hillsdale, NJ: Erlbaum.
Stevenson, H.W. (1972). *Children's learning*. Englewood Cliffs, NJ: Prentice Hall.