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AN INTERPRETATION OF  
PIAGET'S CONSTRUCTIVISM\*

Qui est donc le vrai Piaget? C'est un Piaget  
unique plustôt que multiple.

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Any serious attempt to come to terms with Piaget's epistemological beliefs runs into three formidable obstacles. First, the simple fact that during his productive lifetime -- well over 60 years -- he wrote more than any one person could keep up with; and his ideas, of course, developed, interacted, and changed in more and less subtle ways. Second, as Piaget himself is reputed to have said, he spoke one language to biologists, another to psychologists, and yet another to philosophers; and one could add that, apart from these, he invented a private one to speak about mathematics. Third, although he never ceased to praise the virtue of "decentration" -- the ability to shift perspective -- as a writer, it seems, he did not often try to put himself into his readers' shoes. His passionate effort to express his thoughts in the greatest possible detail impedes understanding as often as it helps it. Even the best intentioned reader is sometimes reduced to a state of exhausted despondence. Yet, I have not the slightest doubt that it is worth struggling to overcome these obstacles, because it can lead to an interpretation that provides a view of human knowledge and the process of knowing which, it seems to me, is more coherent and more plausible than any other. But it is a struggle, an interminable selecting, reconsidering, and discarding. What comes out of this struggle can, of course, not be more than one individual interpretation.

For a constructivist, that is how it has to be. From that perspective there is no way of transferring knowledge -- every knower has to build it up for himself. The cognitive organism is first and foremost an organizer who interprets experience and, by interpretation, shapes it into a structured world. That goes for experiencing what we call sensory objects and events, experiencing language and others; and it goes no less for experiencing oneself. *L'intelligence . . . organise le monde en s'organisant elle-meme* (CRE:311) <sup>2</sup>.

This approach radically departs from the traditional conception of knowledge and reality. Piaget uses these words and only rarely warns the reader that their meaning has been changed. Every so often this creates the impression that he contradicts himself. Therein, I believe, lies Piaget's weakness and the root of the innumerable misunderstandings of which his work has been the victim. Sometimes one cannot help asking oneself whether this opaqueness of expression in so powerful a thinker was an affliction or, rather, a deliberate policy to shield the disciples from too revolutionary an insight. Be that as it may, Piaget avoids explicit definitions of those basic terms. Instead, he suggests and implies the meaning he would give them in a variety of contexts, and these meanings often seem incompatible. It is as though he expected the reader to keep a cumulative record of all the suggestions and implications, to combine and to discard, and eventually to find, without

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being told, the key that unlocks the apparent puzzles. Inevitably, this makes for uncertainty, and I therefore emphasize that the radical constructivist epistemology derived from my analysis of Piaget's use of the terms "knowledge" and "reality", and the concomitant concepts of truth and objectivity, is intended to be no more than one personal interpretation.

### **The Construction of Knowledge**

All knowledge, Piaget says, involves an organization, and the kind of organization he has in mind concerns directed actions <sup>3</sup>.

All knowledge is tied to action and knowing an object or an event is to use it by assimilating it to an action scheme . . . This is true on the most elementary sensory-motor level and all the way up to the highest logical-mathematical operations (B&C: 14-15; 17).

Although these quotations come from Piaget's book on the biological aspects of cognition, they do illuminate his basic epistemological position. The concepts of action scheme and assimilation (and accommodation) are indispensable in Piaget's theory of knowledge. They are also among the most misunderstood. As to the first, much misunderstanding sprang from the fact that Piaget derives the concept of action scheme from that of reflex or "fixed action pattern". Action schemes are, therefore, often tacitly equated with "stimulus-response" mechanisms. This interpretation makes traditional psychologists feel comfortable because it allows them to classify Piaget's theory as an interactionist one -- a somewhat complicated interactionism, to be sure, but not a revolutionary doctrine that would shake their fundamental belief in a universal and real environment with which living organisms interact. On the level of cognition, that interpretation inevitably confirms the notion that interaction provides the intelligent organism with "knowledge" and that this "knowledge", through further interaction, becomes better in that it comes to reflect the environment more accurately. Thus there seems to be no difficulty in maintaining the traditional conception of "knowledge" as a more or less adequate *representation* of the environment. Once that view is established, only a direct contradiction could disrupt it -- and explicit contradictions of our age-old common sense notion of knowledge and the world are difficult to find in Piaget's works. Whenever he says, for instance, that knowledge must not be thought of as a picture or copy of reality (and he says that often enough), it is easy to mistake it for a conventional admonition that a cognitive organism's picture of the world would necessarily be incomplete or somewhat distorted. Any realist will read it as such, rather than take it as an assertion that knowledge, *of its nature*, cannot have an iconic correspondence with an independent ontological reality <sup>4</sup>.

The misconception is abetted by Piaget's frequent reference to adaptation. Indeed, he speaks of "cognitive adaptation" (B&C:201ff) and reiterates the thesis that intelligence is essentially an adaptive function. Given the common notion that, through adaptation, organisms come to correspond to their environment -- the protective coloration of certain animals is a prime example -- "cognitive adaptation" is understood as the generation of

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knowledge that corresponds more and more closely to an external world. But knowledge, for Piaget, is tied to action, and its function is not to describe or iconically to replicate the environment. The adaptedness of knowledge cannot be assessed by comparing it to "reality" and judging how closely it matches -- and Piaget knows very well that this comparison is impossible. Instead, his criterion in both biological and cognitive adaptation is success, be it in terms of survival or comprehension (B&C:210; GE: 15).

I have elsewhere discussed the misleading connotation of "adaptation" and suggested that the term "viability" would be more adequate.<sup>5</sup> From the organism's point of view, on the biological level as on the cognitive one, the environment is no more or no less than the sum of constraints within which the organism can operate. The organism's activities and operations are successful when they are not impeded or foiled by constraints, i.e., when they are *viable*. Hence it is only when actions or operations fail that one can speak of "contact" with the environment, but not when they succeed.

This is one of the crucial points where Piaget remains ambiguous. Physicist and child alike, he says, attribute their mental operations to physical objects in the attempt to understand them. In this there is, indeed, an element of projection. But the important fact is that if the object did not possess those operations, neither physicist nor child could understand the object. *D'autre part, l'objet se laisse faire* (EGE:64; STR:35).

For me, this last expression is crucial. To say that the object -- and here this refers to the "ontic" object or ontological reality in general -- *permits* the operations the subject carries out, is an elegant way of saying that in a given context, the object, the environment, the "reality" in which the acting subject is embedded, does not hinder or prevent the subject's action, and it is this absence of obstacle or constraint that makes the action viable.

Piaget goes on to say that we all know that the object is not always amenable to our actions. But when it does not submit, it is because we have not succeeded in finding the proper operations or the right theories to explain it. Note that Piaget has provided a detailed analysis of the process by means of which the cognitive organism generates relatively invariant "objects" from its experience and *externalizes* them into a framework of space, time, and causality which is itself the result of experiential coordination. (CRE). The constraints that limit the actions to which an object is amenable, therefore, spring to a large extent from the way in which the object was originally conceived<sup>6</sup>. In the present context, however, Piaget seems to take the object as ready-made.

The attribution is the necessary condition of understanding or of trying to understand; if the object permits it, this simply shows that the actions of the subject and the operations of the object have something in common (EGE:64).

In this connection Piaget claims to be a "realist" and argue that this possible convergence of the subject's know-how and object's malleability spring from the fact that both subject

and object are physical and chemical entities. He thus seems to invoke a physical-chemical ontology as the basis of successful interaction. But physics and chemistry are knowledge like any other, and, as Piaget so frequently emphasizes: all knowledge consists of invariants which the experiencer creates and maintains in the fact of changing experience. We shall examine the construction of these invariants in the next section; here I merely want to point out the nature of their connection with "reality".

Summing up what he intends by "structure", Piaget stresses the misunderstandings concerning what is to be called "subject":

In the first place, one has to distinguish the individual subject, which is not relevant here, and the epistemic subject or cognitive core that is common to all subjects at the same level. In the second place, one must contrast, on the one hand, the grasp of consciousness (which is always fragmentary and often distorting), and on the other, what the subject succeeds in doing in its intellectual activities of which it knows the results but not the mechanism. But in dissociating the subject from the "self" and what it "lives" there remain its (the subject's) operations, that is to say, what it draws by reflective abstraction from the generalized coordinations of its actions; and it is precisely these operations that are the constitutive elements of the structures which the subject employs. To maintain that then the subject has disappeared, to make room for the impersonal and the general, is to forget that, in the cognitive domain (as perhaps also in that of moral and aesthetic values, etc.), the subject's activity presupposes a continuous decentration, which frees it from its natural intellectual egocentrism, in exchange, not precisely for a ready-made universal outside itself, but for an uninterrupted process of coordinating and reciprocal relating. It is thus this very process that is the generator of structures in their perpetual construction or reconstruction...There is no structure without either an abstract or a genetic construction (STR:120).<sup>7</sup>

Coordination and reciprocal relations (*reciprocités*) are pivotal concepts in my interpretation of Piaget's conception of knowledge. They are indeed the generative functions in the construction of viable structures -- just as they are key functions in the evolution of viable biological structures. As functions, however, they are quite different. When we are talking about a cognizing organism, acts of "coordination" can refer only to combining or reshuffling, by means of established operations, cognitive elements which are available to the organism *qua* building blocks.<sup>8</sup>

Genesis is but a passing from one structure to another, but a formative passage that leads from the weaker to the stronger; and structure is but a system of transformations, whose roots, however, are operational and therefore tied to the prior formation of the adequate instruments (STR:121).

In cybernetic terms, this means that a system can coordinate (or otherwise process) only signals that are present in the network that constitutes the system. It cannot process items which, from an observer's point of view, may be considered to be the external,

environmental causes of the system's signals. Coordination, thus, is a strictly "internal" affair and, epistemologically speaking, it cannot but be subjective for the coordinating organism. (And an observer who does not claim access to a "God's eye view" <sup>9</sup> must at some point consider himself *qua* experiencing organism and explain his own knowledge internally.)

"Reciprocities", on the other hand, does refer to the organism's interaction with its external environment, in that it characterizes the relation between the organism's structures (biological as well as cognitive) and the environment in which, from an observer's point of view, it lives and operates. But these interactive contacts with the environment are always and necessarily of the same kind: a structure fails because it does not lead to the result the subject has come to expect of it. Cognitive structures, it must be remembered, are tied to action and use. Action and use are something more than random motion or random change -- they are part of *action schemes*, and what differentiates Piaget's action schemes from, say, the behaviorist's stimulus-response connections or the physicist's linear cause-effect chains, is that they (the schemes) are explicitly goal-directed. As Piaget himself has occasionally suggested, action schemes are rather like feedback loops because their inherent dual possibility of assimilation and accommodation makes them self-regulating and therefore circular in that specific sense <sup>10</sup>.

The relation between knowledge and the real World, thus, is reciprocal because any cognitive structure is likely to be modified when it clashes with a constraint. To the organism, the environment manifests itself *only* through such clashes, and the organism can, therefore, conclude no more than that those structures and schemes that have *not* clashed with the constraints of the world constitute a viable way of managing. This is analogous to saying that the biological organisms that are alive at a given moment are viable because they have so far managed to survive. To infer from this relation a relation of "correspondence" would be a non sequitur and a gross misrepresentation. Having avoided contact with obstacles does not tell us how a reality consisting of obstacles is structured. An experience of clash or failure, on the other hand, tells us that the particular scheme employed did not work under the particular circumstances; but since our knowledge of the failure and of the particular circumstances can only be in terms of viable cognitive structures, i.e., structures which, themselves, have *not* come into contact with obstacles, we can know and describe "reality" in negative terms alone. Any notion that cognitive structures could come to reflect ontological reality -- e.g., that we could discover the ontic shape of things by sliding our senses or measuring instruments along the surfaces of things-in-themselves and thus plot deliberate contacts -- is an illusion, because the "space" in which we move, measure and, above all, in which we *map* our movements and operations is the space of our own constructions and any "explanation" in it is therefore necessarily incestuous.

In short, the epistemological view which I find to be the most compatible with Piaget's work is basically an instrumentalist one in which "knowledge" does not mean knowledge of an experiencer-independent world. From that perspective, cognitive structures, i.e., action

schemes, concepts, rules, theories, and laws, are evaluated primarily by the criterion of success, and success must ultimately be understood in terms of the organism's efforts to gain, maintain, and extend its internal equilibrium in the face of perturbations <sup>11</sup>.

### **The Subject's Construction of Reality**

An instrumentalist epistemology that explicitly releases knowledge from the traditional obligation somehow to justify the claim that it reflects the nature of ontological reality, may be considered to have "little philosophical attraction" or to be the manifestation of "an anti-philosophical attitude" <sup>12</sup>. Insofar as philosophers choose to cling to "metaphysical realism" <sup>9</sup>, they must turn away from systems that deliberately break with the tradition of searching for a message from the real world, a message which Kant called *eine Kundschaft . . . , die kein Mensch jemals bekommen kann* <sup>13</sup>. It is, however, unwarranted to justify the reaction against instrumentalist epistemologies by the claim that they inevitably lead to "epistemological and ontological idealism" <sup>12</sup>. As I have shown in the preceding section, that is not the case. The fact that cognitive structures do not and cannot *map* the ontic obstacles and constraints into which they run, neither puts the obstacles' existence in doubt, nor does it deny the experiencer's right to refer to a complex of his viable cognitive structures as "reality". When Piaget said *l'objet se laisse faire*, he quickly added that the object frequently resists and thus constrains our activities. The claim that the cognitive subject constructs its knowledge, therefore, does not imply that, *qua* constructor, the subject is free to do as it might wish. Its constructing is always constrained, and it is precisely the recurrent experience of constructions clashing with constraints that lends an aspect of subjective reality to those constructs which, in the subject's experience, turn out to be viable. From the constructivist perspective, however, the reality of knowledge is in one respect radically different from the reality sought by metaphysical realists; viable knowledge fits into the ontic world but makes no claim whatever that it represents that world iconically.

The crucial problem for realists, be they naive or metaphysical, is to find a way of making plausible that knowledge can, and at least sometimes does, *match* the ontic world. To claim a match, however, one needs to make a comparison.

In order to make a copy, we have to know the model that we are copying, but according to this theory of knowledge the only way to know the model is by copying it, until we are caught in a circle, unable ever to know whether our copy of the model is like the model or not (GE:15) <sup>14</sup>.

That is what skeptics have maintained ever since the Pyrrhonist School. If knowledge cannot *represent* the ontologically real, the question for constructivists turns into what kinds of reality *can* be known -- because constructivists, no less than others, want to distinguish between real and illusory. But this distinction, because it could not possibly be based on match or mismatch with "things in themselves", must be made on the subject's side of the

experiential interface. This presupposes an *active* experiencer and thus accentuates the question of how the cognizing subject originates.

Realists usually ignore the question by presupposing it *as well as* a world of objects, and that it is the subject's task to "know" that world by gathering "data" or "information" about it<sup>15</sup>. Descartes' *cogito ergo sum* seems to infer the *existence* of the subject from the subject's own awareness of a particular private activity. This is close to the radical view I am proposing here, except that, for the constructivist, "existence" must not be interpreted ontologically but epistemologically. That is to say, it refers to the realm of cognitive operating and structuring, and not to the realm of "being" in the traditional sense. Perhaps this could be considered a return to Parmenides, but even so, it leaves open the fundamental *metaphysical* question where the operator and constructor of knowledge comes from. That question would seem to be the most elementary manifestation of the problem of self-reference; knowledge of the origin of the knower.

Piaget touches that problem several times, but in his discussion he shifts each time from the point of view of the subject to that of an observer of the subject.

Starting from a state of centration on a self uncognizant of itself and in which the subjective and objective are inextricably intermingled, the progressive decentration of the subject leads to a twofold movement, of externalization, tending to physical objectivity, and internalization tending to logico-mathematical coherence. But physical knowledge remains impossible without the logico-mathematical framework and it is impossible to construct the latter without its being applicable to "any" object whatever (IIP:115).

"A self uncognizant of itself" can be postulated only by an outside observer who isolates in his or her field of experience a unitary entity and considers that entity a potential "self". For that entity the process of decentration that leads to "externalization" of the physical world and "internalization" of the thinking, cognizing self could at the most be posited after the fact – since it is not cognizant of itself at the time, it cannot experience the distinction as a result of its *own* activity.

The intellectual activity begins with the confusion of experience and consciousness of the self, because of the chaotic lack of differentiation of accommodation and assimilation. In other words, knowledge of the external world begins with an immediate utilization of things, whereas self-knowledge is prevented by this purely practical, utilitarian contact. Thus, there is simply interaction between the superficial zone of external reality and the wholly corporeal periphery of the self (CRE:311).

The apodictic distinction between the organism and things outside it, or between the "superficial zone of external reality" and "the periphery of the self", that distinction is made from the observer's perspective and would be quite impossible for the cognizing organism itself until after it has come to externalize certain parts of its experience as an independent world, and internalized others as parts of the experiencing self.

At the end of a paragraph, part of which I quoted earlier (cf. section I), Piaget makes the somewhat cryptic statement: *En un mot, le sujet existe parce que, de facon generale, l' "etre" des structures, c'est leur structuration* (STR:120) [16]. Piaget says this after he has made the distinction between the individual experiencer's self and the generalized agent of cognitive construction, i.e., the subject as epistemological concept. This "epistemic subject", he says, comes into being because some experiencing self has produced cognitive structures -- and, from the observer's point of view (in this case, the epistemologist's), cognitive structures must have been constructed by someone. Hence, we conceive of a generalized epistemic subject. However, the observer or epistemologist himself is an experiencing self, too, and the epistemic subject of which he conceives is a product of cognitive construction. In short, Piaget seems to imply that the cognitive adventure begins with activity which, since it involves "utilization", is not just activity, but activity towards a given goal. Cognitive structures are formed, some are externalized, others internalized, and eventually the agent of construction finds itself *qua* "self" in the internalized part of experience, facing the externalized part as the surrounding world.

Though Piaget might not have cherished the comparison, this scenario is not unlike the ontogenesis of the self in Buddhist philosophy. In any event, both are an attempt to come to terms with the problem of epistemic self-reference and, as such, one should probably not expect them to be wholly successful. In Piaget's case, however, the approach has led to an analysis of *how* a cognizing agent begins to construct what he or she will ultimately consider "reality". At the core of that process are repetition, regularities, invariants, and rules.

What gives cognitive structures a first, primitive and relative durability is simply repetition. Any action followed by an experience that is in some way "interesting" or "satisfactory" to the actor, will be repeated. (Circular Reactions, (CRE:10ff))<sup>17</sup>. This confers a preliminary, tenuous "permanence" to the link between action and result (action scheme) as well as to the perceptual signals that are coordinated to groups forming the trigger and the result of the scheme respectively. Successful repetition then turns perceptual compounds into items that can be re-recognized *qua* experiential invariants and, eventually, externalized as objects that *exist* on their own, i.e., even when they are not actually being perceived or acted upon. Their recurrence yields a first notion of reality.

A second level of reality is achieved when experiential invariants are formed out of sensory material from different sources. A thing seen as well as touched is more "real" than one consisting of visual signals alone.

On a higher level that Piaget calls "operational", there are schemes for the construction of schemes. They require the actor's awareness of the structure of its own schemes. This awareness is the result of "reflective abstraction" which enables the actor (1) to separate the *patterns* of action from the actual experiential content with which they were enacted; (2) to

transfer them to other circumstances; (3) to homogenize them and make them compatible with one another; and, eventually (4) to shape them into operational invariants that can serve not only in action but also in prediction and explanation (CRE:334f).

Finally, then, the organism construes itself as an experiencer among “others”, as “living in a social context” in which there is a special form of interaction called “communication”. This brings with it not only a new level of action schemes, assimilation, and accommodation, but also a new and more powerful way of validating cognitive structures and knowledge, namely by mutual agreement and confirmation. (The “truth” and “objectivity” that arise from this interaction will be discussed in the next section.)

To sum up, then, instead of a reality that “exists” by itself, independent of the experiencing organism, Piaget’s genetic epistemology postulates, and articulates in sequential steps, a reality that is created by the application of cognitive invariants that structure the subject’s experience into recurrent objects, events, and relations. Given the constant functioning of assimilation and accommodation (i.e., disregarding certain experiential discrepancies and/or modifying cognitive structures to fit experience), these relative invariants provide the possibility of prediction and thus become more and more indispensable in the organism’s struggle to maintain its equilibrium in the flow of experience.

Since this approach is deliberately and explicitly “genetic”, conventional philosophers may discard it as a case of genetic fallacy. If they do, constructivists would ask them for a more plausible justification of their seemingly unshakable belief in a readymade reality and in the fact that they or other cognitive organisms can come to know it<sup>18</sup>. One of the most attractive aspects of Piaget’s epistemology is precisely the fact that it does not require a divinely ordered, pre-established and comprehensible world. Instead, it presents a hypothetical model of the cognizing organism that has the capability of creating for itself, by maintaining a balance of assimilation and accommodation, a stable experiential reality, even if the ontological world were an ever-changing flux.

What then remains is construction as such, and one sees no ground why it should be unreasonable to think that it is the ultimate nature of reality to be in permanent construction instead of consisting of an accumulation of ready-made structures (STR:57-58).

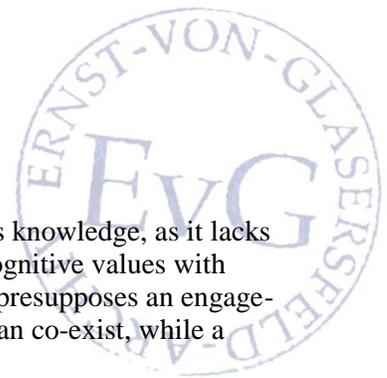
## **The Notions of Truth and Objectivity**

Piaget distinguishes truth from Wisdom.

The main thesis of this work is that philosophy does not give us knowledge, as it lacks methods of verification . . . On the other hand, by coordinating cognitive values with other human values it can give rise to a “wisdom”, but a wisdom presupposes an engagement and therefore several wisdoms nonreducible to each other can co-exist, while a

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single truth is alone acceptable when we deal with a problem of knowledge in the strict sense (IIP:216-217).

To establish truth and its uniqueness, Piaget says, methods of verification are needed. At that point the reader may well balk. Verification would seem to require a match with something external to whatever is to be verified. At least in traditional thought, verification has usually been interpreted as the operation of checking the goodness of knowledge as a copy of "reality" <sup>19</sup>. In an epistemology in which cognitive structures are the result of assimilation, i.e., disregarding differences, and accommodation, i.e., not change toward a better match, but change towards greater viability -- in such an epistemology "verification" and "truth" cannot have the conventional meaning.

I submit that, in Piaget's theory, truth, like reality, must have several levels and that none of them could involve the realist notion of "true representation of reality". Moreover, in Piaget's system, a concept of truth can arise only as a result of reflection. A subject immersed in action either reaches or does not reach the goal. A judgment of true or false is possible only in the context of reviewing action, not in the context of action itself.

On the most elementary level, the level of recognition, there is the pseudo-truth of repetition. An experiential situation triggers an action scheme when the organism can assimilate the situation to past situations in which the particular activity proved successful. In assimilating the situation, the organism simply *takes* it to be the same and, therefore, remains unaware of any differences which an observer of the organisms might detect. No question of truth enters on that level. Once the organism has become able to reflect, however, it has the option of *deliberately* disregarding differences in an experiential situation, in order to carry out a particular action towards a desired result. If, for example, unable to find a proper tool, you use a shoe to drive in a nail, it does not mean that you mistake the shoe for a hammer. Proper description requires that a shoe, once recognized as a shoe, be called a "shoe" and a hammer a "hammer". On that level, then, "truth" is the fit, *without* deliberate assimilation, of experiential things and events into pre-established names. Such a fit, however, manifests itself through the absence of discrepancies and is, therefore, a function parallel to that of viability <sup>20</sup>.

In the case of more complex cognitive structures and their use in prediction and control, that is to say structures that we confidently use to describe and to explain, it is their more or less reliable experiential confirmation that establishes their viability and, eventually, leads us to consider them "true". All this, of course, covers what is usually referred to as "empirical truth", but it does so *without* taking a further epistemologically unwarranted step. When predictions based on some kind of theory repeatedly turn out to be correct, it is often believed that this success is possible only because the theory "represents relevant aspects of reality sufficiently accurately, because it contains at least a kernel of truth" <sup>21</sup>. One does not have to be a constructivist to find that conclusion unwarranted. From a constructivist perspective, however, the situation looks very different. Because all cognitive structures and

theories that are systematically used to order, predict, and control experience are from the very beginning established through successful repetition, there is no way of inferring anything from their success, beyond the fact that they have remained viable up to that point. Nor is there ever a reason to believe that a viable theory is the only possible one in an ontological sense. (It may, of course, be the only one possible, given the cognitive building blocks that are available; and that might tell an observer something about an observed organism, but it could not tell that organism anything about the supposedly independent world.)

Empirical truth, however, is not the only one. Piaget has gone to great lengths to incorporate the "truth" of logic and mathematics into his general framework of adaptation, but he has always remained aware of its essential difference. Speaking of the evolution of the living organism's capacity of self-regulation, its capacity to maintain, albeit never completely, its equilibrium, he refers to *cognitive* regulation and *cognitive* equilibrium as different from *vital*, i.e., organic, equilibration, because the first can be successfully attained, whereas the second remains forever incomplete (B&C:406).

The logical-mathematical structures, in fact, constitute a unique example of an evolutionary development without break, such that no new structure has led to the elimination of a preceding one. The older structures could well be considered not adapted to some unforeseen situation, but only in the sense that they were not sufficient to solve some new problem, and not in the sense that they were contradicted by the very terms of the problem, as sometimes happens in physics (B&C:407).

In other words, the cognitive structures in logic and mathematics do reach an equilibrium that is permanent. What makes this possible is the "dissociation of forms and contents" (B&C:408, 409). One example Piaget gives is the well-known observation that human subjects, presented with a somewhat imperfect figure, will be able to recognize it, say, as instantiation of a geometrical circle (B&C:363). Though he uses that example in connection with the Kantian a priori, it can also serve to illustrate the dissociation of form and content. The perceptual signals in the subject's visual experience supply amorphous content. The *form*, on the other hand, arises from the subject's operations when the individual signals are linked to yield an itinerary of movement or attention that can be assimilated to an already established prototypical curve associated with the name "circle". That set of operations (a program or subroutine, if you will) is the form, and the particular signals that happen to be available are fitted into it. The form, then, is an *operational* invariant abstracted from the subject's own action rather than from perceptual material.

In the case of logical-mathematical abstraction . . . what is given is a set of the subject's own, already available actions or operations and their results (B&C:366).

The question whether or not the given perceptual material will do as content for the particular form, is a question of assimilation. The decision to carry out the program that

constitutes the form, on the other hand, does not involve assimilation; the subject either decides on the program called "circle", or it does not.

The area of geometrical figures may constitute a simple level of operational invariants, but it already manifests the kind of certainty that goes with them. It is a certainty that arises exclusively through "reflection" and has nothing to do with "empirical truth". Its certainty springs from having taken or not having taken the decision to run through a set of operations, and it is irrelevant how well or how poorly any available sensory signals could be fitted into the operational structure <sup>22</sup>.

The cognitive structures that are called logical or mathematical consist of such operational invariants.

Properly speaking, then, logical-mathematical construction is neither invention nor discovery; as it comes about through reflective abstraction, it is a construction in the proper sense of that term, which is to say, it produces new combinations (B&C:367).

Precisely because logical-mathematical thought operates with elements which, in every particular operational context, are *taken as pre-established*, it yields results that are *logically* certain. Thus, the certainty of a syllogistic conclusion, as is well known, springs from the assumed certainty of the premises and not from the viability of any experiential fact. Our interpretation of Piaget, therefore, does not obliterate logical truth but it explicates it as a result of the cognizing subject's interaction with itself, its reflective abstraction from its own operations, rather than as a result of interaction with elements of the externalized world.

At this point we come to what, for this interpreter, are the two main problems in Piaget's epistemological edifice. The first I have touched upon earlier, but it arises once more in connection with logic and mathematics. It is the problem of explaining the fit between the cognitive structures we produce and the structure of our experience. On the sensory-motor level, Piaget has always maintained that the cognitive subject's experience is shaped and defined by the structures it has (assimilation) and that these structures are perpetuated if successful in preserving the subject's internal equilibrium, or modified (accommodation) if they are unsuccessful. Piaget calls this "adaptation", and I have tried to show that adaptation must not be understood as progress towards a better match with the environment but rather in terms of finding viable paths. In discussing the relation between the logical-mathematical structures and experience (B&C:38-395), Piaget consistently uses the French word *accord*. This is somewhat ambiguous, and he does not make clear whether he intends it in the sense of "agreement" or of "harmony". As I read him, he shifts from one to the other. He does say that, on all levels, the internal organization of the organism tends towards continuous adaptation and that this does not signify that the organization becomes a "replica of the environment". But, in his words, it does signify that there is no organizing function *sans un accord avec le milieu* (395). In the light of what I have said earlier, this accord has to be interpreted as harmony, i.e., absence of clash and, therefore, viability.

In another place, however, Piaget expands:

But understanding or explaining cannot be limited to applying our operations to the real and noticing that it "lets it be done"; a simple application remains below the level of laws. To get beyond that level and to attain the causes, more is needed -- it is necessary to attribute these operations to the objects as such and to conceive them as constituting operators in their own right. It is then, and then alone, that one can speak of causal "structure", that structure being the objective system of the operators in their effective interactions (STR:35-36).

After an excursion into modern physics, Piaget comes to the conclusion: "There exist, then, physical 'structures' independent of us but corresponding to our operational structures . . ." [39]. Although this sounds very much like a declaration of realism, he at once mitigates the meaning of "correspondence" by reminding the reader that the concept of causality derives from the child's early success in the instrumental use of sensory-motor action. And that success consists in halving constructed viable schemes, rather than an internal representation of an external reality.

Cutting through some of the apparent loops, we might isolate the following steps:

(a) The active subject organizes sensorimotor experience by compiling action programs and by retaining those among them that are successful in attaining or maintaining equilibrium in the face of perturbations;

(b) By means of reflection, operational structures are then abstracted from the action patterns and attributed to externalized objects;

(c) Having abstracted operational structures from sensorimotor "content" that originally led to their compilation, they can be operated within the climate of certainty and, on that level, they yield "logical-mathematical truth";

(d) On the other hand, operational structures are projected onto objects and thus "externalized". Their continued viability in the face of further experience then leads to the belief in their independent "existence" and, consequently, to belief in their "objective truth".

But "objectivity" has a root also in the traffic between subjects, and that brings me to the second of the two problems mentioned. Although Piaget rarely deals with the phenomenon of communication, he makes one important claim concerning the cognitive operational structures in that connection.

. . . the most general forms of thought, because they can be dissociated from their content, are for that very fact the same as the forms of cognitive exchange or

interindividual regulation, as they are derived from the common functioning inherent in all living organization (B&C:413).

No matter how one turns that statement, it expresses a God's eye view and at once raises the question how, for a subject that cannot have anything but its own experience to work with, the notion of *other* subjects and "cognitive exchange" with them could arise. Piaget, as far as I know, has said little about the epistemological aspect of that problem, and I shall, therefore, deal with it only briefly here, focusing on its connection with the notion of objectivity.

Part of the process of the child's construction of reality is the coordination of object concepts and their externalization as "permanent objects" in space and time. Among these relatively stable sensory-motor objects is also the child's physical self, i.e., the complex of experiential elements distinguished by a certain reliable interrelation that is absent in other coordinations <sup>23</sup>.

As the coordination of its intellectual instruments progresses, the child discovers itself and places itself as an active object among others in a universe that is external to it (CRE:309).

Later in the development, as we have seen, operational structures, invariants, and regularities abstracted from the subject's actions and results, are projected to these objects and thus, eventually, a manageable reality is created in which things, states, and events are causally related.

At an early "intuitive" stage, when moving objects hold a particular fascination, streams, clouds, and winds are imbued with will and anger and other attributes of "life". That is a scheme which, for these particular objects, is soon given up because it does not serve prediction and control. But there are different objects for which it is not only successfully maintained but expanded and complemented with more elaborate schemes that have a similar origin; they all arise from the subject's observation of its own actions, reactions, and intentions. Thus the subject creates *models* of "others" who, in analogy to the subject's experience of itself, come to be considered as perceivers, knowers, and intentioned actors, because such investment does, indeed, make them more predictable.

To know an "other", then, means that one has built up a model out of elements -- properties, functions, and cognitive structures -- that are of the kind one ascribes to oneself but allow for certain differences, and it means that one has so far found that model viable as a means of predicting, controlling, or perhaps only explaining one's experiences with the "other". Communication, including all linguistic activity, is from that perspective a somewhat special form of interaction, but not an exchange of meaning, knowledge, or "information" <sup>24</sup>. What is relevant in the present context is the realization that when a subject feels or says that it *understands* an "other", this implies no more than that the

cognitive structures which the subject has attributed to its *model* of the "other" have so far, or once more, turned out to be viable in the interpretation of the subject's experience.

When certain cognitive structures, then, prove viable, not only in the subject's organizing and ordering of its own experience, but also as the means of organizing ascribed to the models the subject constructs of "others" and *their* effort to organize and order *their* experience -- then these doubly viable constructs acquire a value that can be called "objectivity". That, of course, is the objectivity that is based on the conception of intersubjective agreement, and it makes good sense, given the general assumption that "others", like permanent objects, have been externalized and therefore "exist" in an objective world.

From the constructivist point of view, however, any experiencer's conception of "existence" is a cognitive structure, and qua cognitive structure the construct of a cognizing subject that has in one way or another derived it from its own activity.

### Conclusion

The difficulty in explicating the radical constructivist epistemology springs above all from the fact that, from the very beginning of our Western philosophical traditions epistemology has been tied to ontology. "Truth" and "objectivity" have an unalterable meaning, once the impossible condition has been set that cognition should lead to verifiable knowledge *of* a pre-established ontic reality. Among the many contributions Piaget has made to the intellectual climate of our time, the most important for me is that he has shown a path around that traditional impasse.

The epistemological analysis of a way of knowing consists in determining its necessary and sufficient conditions, not only from a formal or logical point of view, but from the perspective of the relations between the subject's cognitive instruments and the character of the object as it is accessible to that subject's experience (with references eventually, to how it appears in the perspective of subjects of a higher level, which is to say, as an observer's fact) (B&C:248).

Conceptually to separate the experiencer's world from the hypothetical world of a supersubject that observes the experiencer, was a momentous step. Our natural languages, however, being thoroughly impregnated with the realist ontology, make it almost impossible to maintain that distinction. They constantly foster the belief that subjects communicate their cognitive structures and that these structures, to be "true", must reflect a world as it is. Much of what seems contradictory in Piaget's writings can, I believe, be resolved if one continuously keeps in mind that he is analyzing the subject's "cognitive instruments" and the kinds of objects and objectivity the subject could conceivably construct with them. That means that he is trying to explicate the subject's knowledge and reality exclusively in terms of elements which, by definition, are *within* the subject's experience. Although his method

is different, and although he explicitly refutes the assumption of any a priori concepts and categories, Piaget's enterprise is close to how Kant describes his own in the *Kritik*: "I therefore call all insight *transcendental* that does not concern objects as well, but only our way of knowing objects insofar as such knowing is supposed to be a priori possible" [25]. In contemporary terms, such "transcendental" investigation is the study of the mental operations that we consider constitutive of rational cognition. It does not concern the sensory-motor content of thoughts but only their structure. In other words, the study should yield a model of the knower, not a model of the world of being.

At this point -- precisely because the model purports to be the model of a knower -- we cannot sidestep the injunction Leo Apostel pronounced in 1975: *Il faut toujours appliquer un système à soi-même* (EGE:61) <sup>26</sup>.

Piaget's model of the knower, though often conveniently presented as an observer's model of an observed organism, was itself made by an organism who reflected upon his cognitive operations and externalized them. Himself a knowing subject, he could not possibly have been concerned with objects *qua* things in themselves, but only with his way of knowing objects. His model, therefore, will either prove viable in further experience, or it will not. In either case it could not be said to make any ontological claim. Rather, it should be considered in Valéry's words: *l'ennième coup de la partie d'échecs que joue la connaissance avec l'être* <sup>27</sup>.

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#### Notes:

For each Piaget quotation in this chapter a dozen more or less similar ones could have been selected from other books and papers he has written. I have limited my references to six works which I consider among the most representative. Their titles have been abbreviated throughout the text in the manner indicated below. The translations from the French are my own.

- B&C *Biologie et Connaissance*. Paris: Gallimard (1967).  
CRE *La Construction du Réel Chez l'Enfant*. Neuchâtel: Delachaux et Niestlé. 5th edition (1973).  
EGE Inhelder, B., Garcia, R. & Voneche, J. *Épistémologie Génétique et Équilibration*. Neuchâtel: Delachaux et Niestlé (1977).  
GE *Genetic Epistemology*. New York: Columbia University Press (1970). Transl. Ducksworth).  
LIP *Insights and Illusions of Philosophy*. New York: Meridian (1971). (Transl. Mays; second French edition, 1967).  
STR *Le Structuralisme*. Paris: Presses Universitaires de France, 4th edition (1970).

- [1] “Who, then, is the true Piaget? It is a single Piaget rather than a multiple one.”  
Seymour Papert in EGE, p.50)
- [2] “Intelligence... organizes the world by organizing itself.” (CRE:311).
- [3] Cf. also (B&C:210; GE:15; CRE:10, etc.). (Note: it took me several years to realize that “*intelligence*” in this context should be translated as “mind”, a term that does not exist in French).
- [4] “Iconic” is intended in the widest sense, including any kind of *depiction* based on some form of positive correspondence or isomorphism.
- [5] von Glasersfeld, 1977 and 1980a.
- [6] The constraining effect of conceptual building blocks on further conceptual construction has been treated in Richards & von Glasersfeld (1980) and von Glasersfeld (1981).
- [7] One sentence I have omitted here will be given in the next section.
- [8] Similarly, in the context of an organism's biological structure, "coordination" can refer only to a combining of elements which the organism already has -- either owing to its genetic make-up or owing to the accidents of mutation. No organism can spontaneously produce new elements in order to form a new structure. Even the reshuffling of elements, which in Piaget's view could be instigated by stress, must be considered essentially random (cf. Piaget, 1976).
- [9] I owe this expression to an early draft copy of Chapter 2 of Hilary Putnum's book, *Reason, Truth, and History*.
- [10] The cybernetic parallel is elaborated in more detail in von Glasersfeld. (1980b).
- [11] "Equilibration," in the context of Piaget's work, is of course not a static affair which returns to a status quo, but rather a relational concept whose range is continuously extended by the formation of new structures in the overcoming of perturbations.
- [12] Cf. Radnitzky, (1980:198).
- [13] “A message that no man can ever receive.” (Kant: *Kritik*, p. 461).
- [14] Note that Piaget here uses "model" referring to the original of a purported copy. That is not how I shall use the word "model" later in this chapter; instead, I use it to refer to a functional equivalent in the cybernetic sense.
- [15] "Information" is usually used naively in the context of epistemology. As pointed out in von Glasersfeld & F. Varela (1978), “information”, except in the realm of communication theory, may be interpreted as "forming inside" the cognizing organism a viable structure for dealing with an experiential situation.
- [16] “In one word, the subject exists because, in a general way, the ‘being’ of the structures is their structuration.” (STR:120)
- [17] Cf. also Piaget (1951:101).
- [18] Cf. Mays (1954:53-55).
- [19] E.g. “In order to discover whether the picture is true or false we must compare it with reality.” Wittgenstein (1933:43,2.223).

- [20] Indeed, we frequently have to deal with objects whose fit into our pre-established cognitive structures is so poor that we are uncertain about their viability as bearers of a particular name.
- [21] Radnitzky (1980:197).
- [22] That is why, for instance, the geometry teacher does not have to draw a perfect circle on the blackboard -- when he says "circle," he refers to a perfect operational structure which the students already possess (or are supposed to possess) as a mental image and which is perfect by definition.
- [23] A child pinching its own arm, for instance, experiences a combination of sensory signals that cannot be replicated in any other situation (cf. von Glasersfeld, 1979).
- [24] This view of language and communication is fully developed in Maturana (1980).
- [25] Kant, *Kritik*, p. 43.
- [26] "One must always apply a system (also) to itself." (EGE:61).

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