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The Nature of Developmental Stages

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Abstract. A theoretical analysis of the nature of developmental stages is presented. A formal model of the relationship of knowing is outlined from which developmental stages, egocentrism, and vertical decalage can be derived as logically necessary consequences. A number of implications of the model for the nature of developmental stages are discussed, and it is noted that these implications show several important divergences from *Piaget.* The underlying model of knowing is illustrated, primarily with respect to imagery.

I will be arguing that there is a primary class of developmental stages that arise from certain formal properties of knowing. The first half of the discussion develops a model of knowing and one of its major consequences, while the second half explores various implications of the model for human development – primarily those concerning developmental stages.

The development of the model occurs in three steps: (1) an examination of some potential *properties* of knowing that would imply a hierarchy of *levels* of knowing; (2) an indication of a formalization of knowing that in fact manifests those properties and thus that hierarchy, and (3) a suggestion that the knowing model is valid for human knowing and, thus, that the knowing hierarchy applies to human development. Essentially, a model of knowing is indicated which is based on a conceptualization of a knowing system in interaction with its known environment. The model yields the result that a knowing system can itself be

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known only by a higher level system that takes the given system as environment, thus generating a hierarchy of knowing levels, each one interactively knowing the level just below it.

Exploration of the implications of that knowing hierarchy for human development also occurs in three steps: (1) an argument that developmental stages, egocentrism, and vertical decalage follow from the knowing hierarchy; (2) an examination of the problem of identifying the formal stages implied by the model with empirically observed classes of behavior, and (3) a discussion of the general implications of the model for the nature of developmental stages. The core of the argument is that epistemological construction can occur at a given level of knowing only if the necessary supports at lower levels of knowing have already been constructed. Such a constructive ascent up the levels of knowing yields a developmentally invariant sequencing of stages of knowing. This basic feature of an epistemologically constructive stage model is similar (though not identical) to *Piaget*'s, but in other ways the models are quite distinct. For example, the model developed here leads to a rejection of the standard Piagetian identification of stage boundaries, it rejects the definitions of stages in terms of *structures d'ensemble*, and, in general, it recasts the conceptualizations of stage, vertical decalage, and horizontal decalage.

Presentation of the Model

The Relationship of Knowing

As an initial clarification, I would first like to distinguish between an entity in a state of knowledge and an entity in a process of knowing. Knowledge and knowing are clearly highly related, and their formal properties reflect such similarity, but a confusion of the basic distinction between state and process can nevertheless be highly misleading.

Knowing is a binary relationship. That is, it involves two terms: something engaged in knowing, and something being known. Within the broad category of binary relationships, there are a number of potential relational properties with respect to which knowing might be explored. For example, it seems clear that, in general, knowing is not transitive: A knowing B and B knowing C does not necessarily imply A knowing C. It is interesting, in fact, to ask if simultaneous transitivity of knowing is possible. Similarly, knowing is in general not symmetric: A knowing B does not necessarily imply B knowing A. Also similarly, the issue of the possibility of symmetric knowing may be raised.

The relational property to be pursued, however, is that of reflexivity. Again, knowing is clearly not in general reflexive: A does not necessarily know A. The interesting question, however, is whether or not knowing can in principle be reflexive. For, if not, we are faced with a circumstance in which any knowing system, no matter what else it might be capable of knowing, can never know itself. I will suppose during the discussion of this section that knowing is in principle not reflexive.

Immediately another question arises – can knowing systems, which by our current supposition cannot know themselves, nevertheless be known by other knowing systems? That is, can knowing subjects also be known objects? If the supposition in this case is positive, that knowing systems can be known, then system A, which can know some things, but certainly (by current assumption) not itself, might nevertheless be knowable by system B, which in turn might be knowable by system C, and so on. Thus we derive the possibility of a hierarchy of knowers, or at least of potential knowers, extending in principle indefinitely.

It is critical to note that such a hierarchy of knowing would extend to a hierarchy of knowledge: knowers higher in the sequence would be capable of certain kinds of knowledge not available to knowers lower in the sequence. In particular, whatever else A might know, it cannot know the properties of A. B, however, can know the properties of A, but cannot know its own properties, *including those properties of B relating to the knowing of A.* C, in turn, can know the properties of B, but not its own, including those properties of C relating to the knowing of B (as a knower of A). Clearly, the argument iterates, and we find that there is new potential knowledge at each level of the knowing hierarchy *that is specific to that level.* That is, at each level of the knowing hierarchy, there are properties that can *exist only at that level,* and can be *known only at the next higher level.*

Essentially, the supposition that knowing systems can know other knowing systems (that knowing is iterative) has led to the possibility of a knowing hierarchy with a corresponding knowledge hierarchy, and the supposition that knowing is not reflexive leads to the conclusion that such a hierarchy of knowing systems is the only way to access the knowledge hierarchy.[2]

[2] Actually, the additional assumption is needed that knowing sequences cannot loop back on themselves. That is, sequences such as 'C knows B which knows A which knows C' are not possible. The situation is analogous to that of the relation 'father of' which is also not transitive, not symmetric, and not reflexive, but is iterative and produces a similar sequence of 'ancestors'.

I wish to contend (1) that both suppositions are true, (2) that there are corresponding knowing and knowledge hierarchies, (3) that such hierarchies impose a hierarchical or stage structure on possible thought or cognition and (4) that such a hierarchical constraint on possible cognitions is in fact manifested in currently available theory and data. To do so beyond the suggestive level already presented, however, requires a more formal framework within which the loose suggestions in the discussion to this point can be given precise formulation and analysis. What follows is an outline of such a framework and corresponding formulations and analyses.[3]

Representation and Knowing

I am conceptualizing knowing as a special sort of interactive process, and knowledge as the potential for particular knowing interactions. It is, of course, not necessary that particular interaction sequences be somehow stored in an organism sequence by sequence: simple finite control structures (procedures) are fully capable of computing or executing very large (potentially infinite) classes of interaction sequences. Formalization of the concepts of knowledge and knowing should thus be possible within appropriate formal control structure languages.[4]

The actions of a system in an environment will in general be determined by the overall internal condition or state of the system, while that internal state will be jointly determined by the prior state and whatever inputs are received from the environment. Thus we have a cycle – input from environment, change of internal state, output to environment – that will be repeated so long as the system is successful in shifting from state to state in accordance with its control structure. A system in interaction with its environment will be said to be *knowing* (some characteristic of) that environment insofar as the interaction

[3] The discussions in this article are part of a general attempt to construct a formal model of psychological processes. Currently, the model spans, at least skeletally, from processes at the levels of knowing, learning, emotions, and consciousness, to those at the levels of language, personality, and the construction of social reality. Further presentations, elaborations, and refinements of this model are contained in, or planned for, *Bickhard* (1973, 1978a, b).

[4] Such mathematical languages are generically classified as abstract machine theory or computation theory. Automata theory and Turing machine theory are the particular languages that I have been most concerned with to date (see *Davis*, 1958; *Ginzburg*, 1968; *Minsky*, 1967).

does not yield a condition in the system for which the system's actions are not defined – that is, insofar as the interaction is well defined from the system's perspective.

Suppose the control structure has more than one internal state or condition in which it can find itself at the end of an interaction, and note that the particular state in which it does terminate depends on (is partially determined by) the environment with which the interaction is taking place (that is, suppose the system is a Moore machine that is also a recognizer; see *Ginzburg,* 1968). Then, the particular final state in which the interaction terminates will serve to classify that environment: the environment will be of the sort that yields final state A, say, or final state B. Since this classifying information is internal to the system, it is available for the determination of further processes. In this sense, the control structure, via its class of potential final states, represents a set of environmental categories, constitutes the potential for interactively knowing instances of those categories, and thus constitutes knowledge of those categories. Note that the interaction may not only have classified the environment, but, in general, will also have changed it (via its outputs), and that this change will also be available to further processes.

This concept of knowing is not particularly difficult to formalize within formal control structure languages, and, once thus formalized, the theses that knowing is not reflexive, and that it is iterative, follow readily via results already in the literature.[5] The knowing hierarchy then follows as indicated in the preceding section.

Human Knowing

The knowing hierarchy and its implications, however, follow from the particular explication of the knowing relationship indicated. The claim that the knowing hierarchy is a structural characteristic of human knowing is therefore only as strong as the claim that the given explication of knowing is sufficient to

[5] Nonreflexivity, i.e., that a system cannot fully know itself, is essentially a corollary of *Gödel*'s theorem (see, e.g., *Boolos and Jeffrey,* 1974). Iterativity follows via *Gödel* numbering of Turing machines and the recognizability of Turing machine *Gödel* numbers (*Davis,* 1958).

(applies to) human knowing. Thus it becomes critical to examine the adequacy or sufficiency of the knowing model to human knowing.

The issue is deeply complicated, however, by the fact that the adequacy of the knowing explication to human knowing cannot be proven in principle, since we have no formal knowledge of human knowing with which to compare it.[6] The claim is not provable, but it is falsifiable – falsifiable by a counter-example. That is, it would be falsified by finding a characteristic of knowing which is demonstrably not modelable within the given explication of knowing, and which is demonstrably necessary to adequately model human knowing. The demonstration of the applicability of the knowing hierarchy to human knowing can thus be approximated only by the failure to find counter-examples to the adequacy of the knowing model. A full demonstration would require the satisfactory modeling of all characteristics and types of human knowing and representation, and, since this is an infinite task, it can only be approached via the successful modeling of broader and broader classes of such characteristics and types. A massive modeling task will not be attempted here. I intend rather to develop a few distinctions and illustrations as suggestive of the framework and approach for such a broader task.

A finite system can have at most some finite number of the knowing levels within it – each level corresponding to a subclass of control structures or procedures of the overall system. There must be, therefore, a highest level of procedures in any knowing system. Procedures at this highest level have a special distinction: like procedures or control structures at all other levels, they are available for execution, for controlling a knowing interaction (possibly internal to the system), but, unlike procedures at all other levels, they cannot themselves be taken as objects of knowing (by that system) – they are not part of the system's knowable world. Thus, from the perspective of the system, they are not known to exist (though they might come to be known if the system should acquire, i.e., construct, procedures at the next higher level). This functional distinction will be made by referring to highest level procedures in a given system as *virtual* procedures, and to all others as *real* procedures.

[6] It shares this problem with all attempts to formally explicate informal concepts. See, for example, the discussion of *Church*'s thesis in *Rogers* (1967) or in *Boolos and Jeffrey* (1974). The thesis of the adequacy of the knowing explication to human knowing is in effect a particularization of *Church*'s thesis (or, equivalently, *Turing*'s thesis), and thus receives support from those broader theses. *Church*'s thesis has not been falsified in some 40 years of mathematical investigation.

It is clear from the nature of the knowing hierarchy that particular control structures may function in one of only two possible manners: (1) a procedure may be executed or (2) it may be taken as an object of an interaction controlled by some other procedure. A procedure (control structure) thus constitutes knowledge in two corresponding senses: (1) as available for controlling knowing interactions and (2) as available for 'consideration' by higher level procedures (assuming appropriate higher level procedures exist). A given procedure, for example, might be, on the one hand, capable of guiding a machine around a room full of objects without bumping into anything, and, on the other hand, available as a representation of the position of obstacles in that room to a higher level procedure. Procedures being executed will be said to be functioning as *plans;* procedures being taken as objects of knowing will be said to be functioning as *images* (clearly motivated by the 'plan and image' of *Miller et al.*, 1960).

Virtual procedures cannot function as images, only as plans. Nevertheless, there is a sense in which they do constitute a representation of their objects of knowing: precisely the sense in which they do successfully control interactions with those objects (clearly, 'object' in this usage can be of any degree of abstraction). This is precisely the sense in which they could be useful as images, if there were appropriate procedures at the next higher level. Virtual procedures might thus be said to constitute *virtual images* of their objects of knowing, with real procedures thus constituting *real images.*

The sense of the concept of image explicated here is quite compatible with *Piaget*'s conceptualization of image as derived from internalized imitation (*Piaget and Inhelder,* 1969), though not so directly compatible with image as derived from perception (e.g., *Bruner et al.*, 1966; *Paivio,* 1971). In particular, insofar as a procedure is successful as a plan, it must be accommodated to (imitative of) the characteristics of the environment with which it interacts (*Piaget,* 1962), and this is precisely what makes it useful as image. That is, the successful plan must accommodate (imitate) the interactive characteristics of its appropriate environment in order to control behavior in accordance with that environment, and it is precisely those interactive characteristics which it serves to represent (as image) to appropriate higher level plans. On the other hand, although it has not been made so clear exactly what perception consists of in this model, it is evident that there is little room for purely passive impressions. Perception, in fact, must in some sense consist of the outcomes of the interactions of lowest level plans. Note that these are transient conditions in the knowing system, and thus would seem to provide no foundation for long-term images.

The knowing model thus connects with a particular theoretical orientation towards a particular mode of human representation — that is, with *Piaget's* conceptualization of imagery. In so doing, it (1) suggests a potential direction of formalization of *Piaget's* views, (2) lends support to those views and (3) makes itself vulnerable to empirical criticism. For current purposes, however, it is most important to note that it suggests the potential adequacy of the original explication of knowing to at least this characteristic of human knowing (imagery), and thus supports the claim that the knowing explication is adequate to human knowing, and therefore that the knowing hierarchy applies to human beings. It is an example of the (partial) construction of a submodel of a type of human knowing within the overall knowing model.

A great deal more exploration of the adequacy of the knowing model to human knowing would be needed to make a strong case for that adequacy, but this is not my present primary concern. Therefore, I will assume the validity of the knowing model and proceed to an exploration of the implications of the knowing hierarchy for the nature of developmental stages.

Implications of the Model

Stages, Egocentrism, and Decalage

The suggested formalization of knowing implies an indefinite hierarchy of levels of knowing. Assuming the validity of the knowing model for human knowing, the constraints of the knowing hierarchy must also apply to human beings. Such a knowing hierarchy implies a number of characteristics of development of which I will briefly examine three: developmental stages, egocentrism, and decalage.

If we conceptualize cognitive development as a progressive construction of procedures, it is clear that the knowing hierarchy implies the existence of stages of development: procedures at a given level cannot exist without procedures at the next lower level for them to operate on. The construction processes must begin with level one, then proceed to level two, then to three, and so on. Correspondingly, the forms of knowledge available at level one must be manifested before those available at level two, those of level two before those of three, and so on. If the explication of knowing is valid, then mental development must manifest the constraints of the knowing hierarchy as developmental stages.

The derivation of egocentrism requires a somewhat more careful analysis. A particular procedure at a particular level of knowing serves to represent a corresponding particular property or aspect of its object of knowing – it represents its object from a particular abstract perspective. Other procedures at that same level may well represent other aspects of the same object, and collectively such procedures and their interconnections may represent a structure of perspectives on their common object of knowing. Within that level of knowing, however, only one of those procedures can be in process at a given time – the system can only operate within one perspective at a time.

Coordination of perspectives on a common object will thus require knowing systems at a level higher than that at which the perspectives themselves are represented. Such a higher system can take the structure of perspectives as a real image and examine their properties *qua* perspectives, including their interrelationships. But, if there is no higher level available, if the perspective representations being considered are virtual for the overall system, then that system is in 'a cognitive state in which the cognizer sees the world from a single point of view only – his own – but without knowledge of the existence of viewpoints or perspectives and, *a fortiori*, without awareness that he is the prisoner of his own' (*Flavell*, 1963, p. 60). This is precisely a state of egocentrism.

The knowing model thus logically implies that any knowing system will manifest egocentrism with respect to its highest (virtual) level of knowing – it must, since it by definition has no higher level within which perspective coordinations can take place. In a developing system, egocentrism will thus manifest itself at progressively higher levels as the system ascends the knowing hierarchy in its development.

There are actually two kinds of egocentrism implied for a developing system. As a system begins to develop procedures at a new level of knowing, the perspectives corresponding to those procedures will be sparsely interconnected, and the system will thus have relative difficulty in coordinating those perspectives in execution (action). As development proceeds, the interconnections will fill out and the system's executions will become more coordinated. It will still be restricted, however, to execution within one perspective at a time, and the anticipatory coordination of perspectives before their execution will await construction of the corresponding higher level procedures. Thus there is at first a lack of coordination of perspectives in execution, followed by a lack of coordination of perspectives in anticipation. Egocentrism generally refers to the lack of anticipatory coordination.

Such a progression of decentering at one level of knowing via the development of coordinating systems (with their own egocentrisms) at the next level already illustrates the fundamental characteristic of vertical decalage: the construction of new higher level procedures representing (and interacting with) old systems of functioning.

For example, with the development of object constancy, the infant comes to recognize a given object – *behave* towards it in a constant fashion – despite changes in the perspective from which it is seen. It is not until much later that the same child can internally *represent* the system of possible perspectives, as opposed to acting appropriately within any one perspective (*Flavell,* 1963, pp. 22–23).

Vertical decalage thus reflects the fact that procedures at a given level of knowing must interact with, and thus must represent, properties of procedures at the next lower level. Vertical decalage derives from viewing development as a progressive construction ascending through the knowing hierarchy.

The knowing hierarchy imposes strict sequencing constraints on development, thus stages and vertical decalage, but is in itself neutral to the possibility of other sequential constraints operating within particular knowing levels. The existence of horizontal decalages indicates that such within-level sequential constraints do exist. Their nature, however, cannot be explored within the knowing hierarchy: the hierarchy suggests an explication of vertical decalage, and provides a distinction between horizontal and vertical decalage, but the analysis of horizontal decalage *per se* is intrinsically an analysis of development *within* the knowing hierarchy, not a derivation from that hierarchy.

Within-level sequential constraints on development *can* be analyzed, however, within the framework of the general knowing model. One of the more obvious candidates for within-level sources of sequencing constraints is the hierarchicalization of subroutines: a higher level subroutine requires the existence of lower level subroutines. Subroutine hierarchies, however, impose different kinds of, and generally more complex, constraints on development than does the knowing hierarchy. Furthermore, there are other, often even more subtle, constraints on within-level development than subroutine hierarchies. Within-level developmental constraints are fascinating, but it is beyond the intent of this article to pursue their analysis.

Identifying the Stages

To this point, a twofold succession of strict implications has been developed: the formal knowing model implies an infinite hierarchy of levels of knowing, and the knowing hierarchy implies developmental stages, egocentrism, and decalages. Furthermore, it has been suggested that the knowing model is valid for human knowing, and thus that human development is constrained by that hierarchy and its implication.

Being constrained by the knowing hierarchy, however, does not at all insure that any particular level of the hierarchy is actually manifested. It is clear, in fact, that at most a finite number of the levels can be manifested in any population of finite entities, and that that finite number might well be one. Thus, for example, evolution on earth might not yet have generated a level two knower. The variations in knowing capabilities that we observe among individuals and species might all be variations within level one, rather than across levels.

If we assume, however, that more than one level is manifested by current knowing systems, then we are faced with the problem of matching those manifestations with the corresponding levels. It is clear that the new knowledge available at level N is knowledge about level N-1. But it is not necessarily clear what that new knowledge consists of, and therefore not clear how to empirically recognize it. Empirically identifying the stages thus depends on being able to specify empirical manifestations of the corresponding levels.

Identifying a manifestation of a particular stage in a given knower obviously also constitutes demonstrating the existence of the corresponding level in that knower. Thus the problem of demonstrating the existence of a level has basically the same solution as that of identifying the manifestations of that level. There is one major difference, however: it requires confidence in the identification of only one manifestation of a level to demonstrate existence of that level, while the *full* problem of identification of a level ultimately involves specification of all possible manifestations of that level.

The intent at this point is to illustrate the process of identification with an example from an earlier discussion: imagery. Essentially, I will contend that distinctions already drawn are sufficient to identfy at least two stages in cognitive development. Level one procedures know about and operate on the external environment. Level two procedures know about and operate on those of level one. The problem is to identify the consequence of this difference in particular empirical manifestations – specifically, imagery. A child with only level one procedures could have not real procedures, and thus no real images. He will have virtual images, however. Level one virtual images would only be available for execution (action), not for consideration or thought. They would constitute an image in the sense that they would capture information about the structures and relationships in the external physical environment, making that information available (and available only) for action in that environment. Thus they constitute information that reproduces static (configural) properties of the environment available for controlling action in that environment. (Note that control structures are themselves static structures, and thus are well suited to 'reproducing' static configurations of their objects of interaction, but provide little direct foundation for representing motions or transformations of those configurations.)

A child with two levels of procedures, however, would be capable of first level real images. First level real images differ from first level virtual images in two critical senses that I wish to emphasize: (1) first level real images can be examined and operated on by second level procedures to draw conclusions that anticipate properties of the environment that have not yet actually been encountered, but are nevertheless implied by information already present, and (2) first level images together with appropriate second level operators on them can constitute virtual images of motions and transformations of the configurations represented by the first level procedures.

First level virtual images are reproductive and static and available only for action, while first level real images are capable of supporting inferential anticipations and transformational or kinetic representations. Thus, the distinction between first level virtual images and first level real images exactly parallels *Piaget*'s distinction between preoperational and concrete operational images (*Piaget and Inhelder,* 1971). *Piaget*'s evidence for anticipatory and transformational imagery is therefore also evidence for the existence of second level knowing.

It should be noted that *Piaget*'s preoperational reproductive static imagery does not constitute evidence for two levels of knowing. Contrary to our intuitions of imagery as involving an 'object' and an observer, and thus seemingly requiring two levels, the behavioral evidence for preoperational imagery requires only that configural information about the environment be available to guide (control) behavior, and this is perfectly compatible with first level virtual images.

This raises issues of its own, however, for, unless we find some other means of demonstrating that preoperations involve second level knowing, we are forced to conclude that the distinction between the sensorimotor period and preoperations is a distinction within level one, not a distinction between levels, and that raises the issue of what the distinction is based upon. On the other hand, if we conclude via some other manifestation that preoperation does involve second level knowing, then the question is raised of why it does not manifest real imagery. Actually, I have as yet not found any property of early preoperations that requires second level knowing, and therefore contend that the end of the sensorimotor period is a within-level boundary.

It is not true, however, that I have found no evidence of second level knowing in preoperations. I have come to the conclusion, in fact, that second level knowing begins about age 4, generally corresponding to the beginning of *Piaget*'s intuitive subperiod, and thus to the conclusion that *Piaget* has generally correctly identified the developmental stage boundaries, but has in some cases misidentified which of them are primary and which are subsidiary. This, of course, does not affect the conclusion that the sensorimotor period is a within-level distinction, and, in fact, raises similar questions about the nature of the beginning of concrete operations.

Consideration of the virtual-real distinction has derived evidence for second level knowing from *Piaget*'s investigations of imagery, and, in so doing, has raised questions concerning the nature of the sensorimotor period. To go beyond this illustrative example of the identification of levels of knowing would require the development and presentation of other observable manifestations of particular levels of knowing. At this point, however, I wish to adopt the conclusion that human beings do manifest multiple levels of knowing,[7] and proceed to a discussion of the implications of those levels for the nature of cognitive stages.

The Nature of the Stages

Rather than attempt an exhaustive discussion of the nature of the knowing model stages, I intend to focus on some of the implications of the knowing model concerning the nature of the stages that differ from current stage models. An initial difference is that the knowing model stages are differentiated by their potential levels of knowledge, not by their within-level structures. The only constraint on the structures within a given level is that they be appropriate to

[7] At least three, in fact. At a very general level of discussion, level one knowing allows virtual representation of objects in space, level two allows virtual representation of relations among and properties of (propositions about) those objects, and level three allows virtual representation of properties of, and operations upon, those propositions. This level of generality allows only a rather crude identification of the stages, and it risks misinterpretation (e.g., in what sense is a first level child *not* capable of representing 'relations among' objects?), but it is sufficient to suggest a general correspondence with the course of cognitive development.

their objects of knowing. It may well be that species-standard contents of knowing manifest particular observable structures, e.g., that propositions are subject to the INRC group of logical operations, but (contrary to *Piaget and Inhelder,* 1969) such structures are secondary characteristics of the levels, they do not define them. Thus, what makes the INRC group a manifestation of third level knowing is not that it has a group structure, but rather that it takes propositions as objects. Furthermore, it has a group structure precisely and only because propositions admit of such a structure of operations.

It is clear, in fact, that structures in their most abstract sense could never have been taken as definitive of the stages. We find, for example, in *Piaget*'s own writings groups in every Piagetian stage: the group of hand displacements of eye-hand coordination in the sensorimotor period, the group of locomotor displacements in preoperations, the group of addition on the integers in concrete operations, and the INRC group in formal operations. *Piaget,* as a matter of fact, seems to have been consistently careful regarding this point, and discusses the stages in terms of particular instances of the structures, e.g., the INRC group, rather than the abstract structures *per se.* Thus *Piaget* is always consistent with a content distinction, but the emphasis is always on the structures manifested by those contents (and this relative emphasis seems to grow in commentators on *Piaget*).

The point is perhaps most clearly drawn with respect to groupings in concrete operations. The groupings are in fact defined in terms of structures of particular contents (e.g., *Flavell,* 1963), but the emphasis is so strongly on the structure that the grouping structure *per se* is commonly taken to be definitive of the concrete operational period. Thus, issues such as the presence or absence of such structural properties as transitivity or reversibility in particular stages come to be couched in completely content-free terms.

The knowing model suggests that groupings appear in second level knowing because they are appropriate to what is being known in the first level, and that they would appear in any other level as well for which there were appropriate objects. Thus, for example, the knowing model is not embarrassed by potential evidence for transitive inferences in preoperational children (*Bryant,* 1974), as long as the objects about which the inferences are made are appropriate to the level of knowing. The structures are not unimportant, but they are derivative from the objects: the emphasis is reversed.

The knowing model stages are not only structure-independent (except in subsidiary senses), they are also content-independent. That is, they depend only on level of knowing, not on type of knowing, and thus apply with equal strength to cognitive development, social development, language development, emotional development, and development within all other general realms of knowing. By thus separating level of knowing from type of knowing, the model disambiguates two potential kinds of developmental dependencies: (1) a dependency on a general level of knowing, e.g., a certain kind of social role taking may require a particular level of knowing, and (2) a dependency on specific skills at a given knowing level, e.g., a form of moral reasoning might require specific role taking skills as well as a general knowing level, but those role taking skills are not likely to directly require (say) volume conservation skills.

Another characteristic of the knowing model stages is that there is an infinite number of them. This suggests the possibility that more than three levels might be manifested by some members of the current population, and encourages looking for them. There is some evidence, in fact, for at least four levels in some people (*Powell*, 1971). The critical problem here, of course, is that of the identification of distinguishing empirical manifestations of such higher levels.

Furthermore, all of the levels have exactly the same abstract relationship to their adjacent levels, that of the iteration of the knowing relationship. Such a single principle involved in the relationships between adjacent stages is difficult to argue for in *Piaget*'s model (compare the sensorimotor-preoperational relationship to the concrete-formal operational relationship), and seems to be nonexistent in any other stage model. Varying principles involved in the relationships of adjacent stages argue for inconsistencies in the definition of stage, and suggest that important distinctions may be being missed by failing to consistently apply all of those principles at all points of development (usually, of course, the principles of adjacency are simply vague and unclear; see, e.g., *Erikson*, 1950). They also make it difficult to reach valid general conclusions about the nature of the stage structure.

Finally, it should be noted that the sequencing of the stages in the knowing model is logically entailed by the definition of knowing. Such an intrinsic ordering of the stages is often pointed out between concrete and formal operations (one cannot have operations on operations until there are some operations, *Flavell*, 1963), but is at best alluded to regarding the other stages, and is not mentioned regarding other stage models.

The characteristic of the intrinsicness of the sequencing of the stages deserves further comment. There is no guarantee that any particular set of stages observed or postulated in child development will be intrinsically ordered. Freudian stages, for example, at least the early ones, are explicitly assumed to be sequenced by neural maturation, not by logical necessity. The stages may nevertheless be quite real and important to the understanding of child development, regardless of their sequencing principles. By the same token, however, there may well be intrinsically structured properties of development, and neglecting this possibility could be perilous.

For example, suppose the knowing model to be valid, and thus the developmental stage sequencing to be logically intrinsic, and someone asks the question of why the stages occur in the particular order observed. Such a question is almost always assumed to require a causal answer, and, since it seems unlikely that the sequencing is derivative from environmental regularities, it follows (assuming a causal framework) that it must derive from some genetic regularities, and one might well be off exploring the behavior genetics of the stage sequencing. Clearly, intrinsic structuring is a third alternative, which, if true, would render the causal (genetic) considerations and investigations completely fruitless. Thus the possibility of intrinsic structuring must always be considered. (The false assumption of the exhaustiveness of genetic and environmental sources of explanation is rampant in the controversy over innateness in language development; see, e.g., *Fodor et al.*, 1974. Innate in the sense of nonenvironmental does not necessarily imply genetic, it might instead be intrinsic.)

References

Bickhard, M.H.: A model of developmental and psychological processes; unpublished doctoral diss. Chicago (1973).

Bickhard, M.H.: Cognition, convention, and communication; manuscript (1978a).

Bickhard, M.H.: Toward a model of psychological processes (in preparation, 1978b).

Boolos, G.S. and Jeffry, R.C.: Computability and logic (Cambridge University Press, New York 1974).

Bruner, J.S., et al.: Studies in cognitive growth (Wiley, New York 1966).

Bryant, P.: Perception and understanding in young children (Basic Books, New York 1974).

Davis, M.: Computability and unsolvability (McGraw-Hill, New York 1958).

Erikson, E.H.: Childhood and society (Norton, New York 1950).

Flavell, J.H.: The developmental psychology of Jean Piaget (Van Nostrand & Reinhold, New York 1963).

Fodor, J.A.; Bever, T.G., and Garrett, M.F.: The psychology of language (McGraw-Hill, New York 1974).

Ginzburg, A.: Algebraic theory of automata (Academic Press, New York 1968).

Miller, G.A.; Galanter, E., and Pribram, K.H.: Plans and the structure of behavior (Holt, Rinehart & Winston, New York 1960).

Minsky, M.: Computation: finite and infinite machines (Prentice-Hall, Englewood Cliffs 1967).

Paivio, A.: Imagery and verbal processes (Holt, Rinehart & Winston, New York 1971).
Piaget, J.: Play, dreams and imitation in childhood (Norton, New York 1962).
Piaget, J. and Inhelder, B.: The psychology of the child (Basic Books, New York 1969).
Piaget, J. and Inhelder, B.: Mental imagery in the child (Basic Books, New York 1971).
Powell, P.: Higher level cognitive and social competence stages; unpublished doctoral diss. Chicago (1971).
Rogers, H., jr.: Theory of recursive functions and effective computability (McGraw-Hill, New York 1967).

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