STAGE AND STRUCTURE

Reopening the Debate

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*Similarities Between Developmental Sequences at Different Age Periods**

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Introduction

We could be forgiven for thinking that Brainerd's (1978) well-documented article, "The Stage Question in Cognitive Developmental Theory," together with the 44 open peer commentaries arising from it, would have closed the debate on this subject for several years. Apparently this is not the conclusion arrived at by the organizers of the present workshop on human development, and neither is it the conclusion to which I have come. I experienced a certain uneasiness reading his article. It is as if the stage problem was never really dealt with. Although the article is concerned with precise experimental criteria and results, these criteria and results are not situated within a broader context. In particular, it should have been necessary to clarify the epistemological options that led Piaget to pose developmental problems in the terms we know. I feel we should take a step backward to establish a certain distance from the stage problem in psychology. For Piaget, for example, the stage problem is omnipresent and the criteria he tried to clarify a posteriori are already to be found in the premises of his theory. Consequently, these are not necessarily the criteria to set us on the right track. It is as if Brainerd, in his article, had omitted redefining the object of study of developmental psychology in favor of a discussion too exclusively centered on criteria for stages as they were established by Piaget. It is for this reason that I would like to use a different route to approach the problem concerning us today.

Preliminary Questions

The object of psychology is the study of behaviors. These may be defined as the means of exchange between the subject and his or her environment. More specifically, developmental psychology is concerned with the problem of *the acquisition of new behaviors,* in other words, with new modes of interaction or exchange

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between the subject and his environment. Based on this, I would like to raise a certain number of questions:

- Are there steps in the acquisition of a new behavior?
- Are these steps the result of an arbitrary partitioning or do they manifest qualitative changes?
- Do these steps have characteristics common to the acquisition of a more general class of behaviors?
- Is the acquisition of a new behavior carried out by passing from simple to complex, from elementary to composite, from noncoordination to coordination, from local to global, etc., as it is more or less explicitly assumed?
- Does the child's acquisition of a new behavior depend principally on:
  - the characteristics of the environment, i.e., confrontation with a new task or situation and the manner in which it is confronted?
  - previously acquired behaviors?
  - the characteristics or resources of the organism, such as age and degree of maturity of the organism?
- Do the characteristics or resources of the organism only define prior or prerequisite conditions, or do they also determine the order and sequence of this construction (as seems to be manifested by the laws of maturation of the nervous system: cephalo–caudal, proximo–distal and antero–posterior development)?

For me, it seems desirable to take, as a point of departure, the problems posed by the acquisition of a new behavior—in our case, learning to read—in order to see whether the problems encountered are peculiar to this behavior or whether they may be found more generally in the acquisition of other behaviors, whether at the same or at other periods in development. We will therefore try to elucidate the necessary conditions for the acquisition of new behaviors and the principal steps in these acquisitions. In this indirect manner we hope to be able to make some remarks on the general problem of stages.

Before entering into details, it will once again be useful to make one or two general remarks.

Justification of an Approach

In my opinion, developmental psychologists would do well to give up an approach to behavior which is *exclusively* analytical or fragmentary in favor of a reconsideration of the major acquisitions of childhood: reaching, walking, speech, language, writing, reading, arithmetic, etc.—behaviors which fascinated psychologists at the turn of the century. If we look critically at the experimental situations which have been devised over the past few decades, we will notice that they present extreme simplifications and impoverishments of reality. Striving to be more experimental, they turn out to be more and more fragmentary. This does not imply any opposition on my part to strict experimental approaches, but we should be conscious of their limitations as well as of their advantages. Above all, it is necessary to *place*

studies of specific problems within broader contexts. Without the broader contexts, these simplifications discard an important part of the general problems to be solved by the child and denature our very conception of development. This position has been adopted by some authors over the past few years, and I am among them. Psycholinguists in particular have recently been led to "recognize the limited, even inappropriate, nature of the recourse to isolated phrases to study both the emergence and development as well as the functioning of linguistic operations in the adult" (Hupet & Kreit, 1983).

Among the child's major acquisitions during his or her development, certain of them, such as reaching and speech, are acquired more or less "naturally," i.e., without systematic adult intervention, whereas others, such as reading, writing, and arithmetic, require the intervention of relatively well-defined pedagogical practices. Now, in their concern to control the role of the environment and, in particular, pedagogical practices, developmental psychologists have often avoided the study of behaviors learned at school, preferring to leave this to educational psychologists (division of labor, you understand!). We are all convinced that there are no spontaneous nor natural acquisitions which would occur without environmental intervention; we are convinced to such an extent that psychologists (and I am one of them) have preferred to make developmental studies of those behaviors where the precise role played by the environment is unknown, (i.e., not subjected to strict school learning) rather than studying behaviors where the role played by the milieu (school, in particular) in their acquisition is more precisely defined. Other factors have also contributed to this state of affairs,—for example, the prejudices and criticisms relating to school, with the more or less explicit idea that school plays a rather negative role in the cognitive development of the child—as if it impeded his "natural" capacities or at least did not sufficiently develop his potential. Of course I agree that schooling may, in some cases, impede the creative and imaginative potential of the child. But it is also important to recognize the valid basis of certain pedagogical practices which are the result of knowledge acquired over many years of experience. This is particularly the case regarding the ages at which certain activities are taught. The teaching of reading and writing, which takes place in our cultures when the child is 6 years old seems to me precisely to be founded on a profound knowledge of the child's competencies.

The questions I would like to raise are: How do developmental psychologists justify the age of six years to begin teaching reading and writing in an alphabetical system? Is this choice to teach a new behavior simply a convention which does not take account of the competences of the child? If it does take these competencies into account, are these principally cognitive competencies? Should the maturation of the nervous system be considered as a determinant condition? And if we talk about intellectual maturation, what exactly does this entail? Similarly, how do psychologists account for this "disposition" or "readiness" to learn a new behavior, specifically this "readiness to read" (cf. Breckinridge & Vincent, 1965, cited by Siegler & Klahr, 1982)?

From my point of view, this question of disposition—of prerequisites—for the

acquisition of a specific behavior is at the very heart of the stage problem. Siegler and Klahr (1982) introduced their article entitled "When Do Children Learn?" in a similar way. Effectively, they considered that the concepts of "readiness," "critical periods," "stages," and "matching" ("an appropriate match between the circumstances that a child encounters and the schemata that he has already assimilated into his repertoire," according to Hunt, 1961, cited by Siegler & Klahr, 1982, p. 127), constitute different ways of approaching one and the same problem—learning new behaviors. I would like to point out that for me the problem is taking account not only of assimilated schemata but also the internal maturation or transformation of instruments of knowledge (or cognitive capacities, or cognitive competencies) where the influence of the milieu would only be nonspecific (Mounoud, 1979/1981).

The Acquisition of a New Behavior: Learning to Read

Boundaries of the Problem: Teaching in the Strict and in the Broad Sense

I would like to show that *there exist conditions related to the development of cognitive competencies in the child which are able to justify teaching reading in the strict sense, within an alphabetical system, around 6 years of age.* I do not wish to imply that this instruction may not be preceded by other teaching but that, in this case, it is not teaching alphabetical reading in the strict sense but rather other activities more or less directly related to reading which we will call *reading in the broad sense.* This, of course, includes many activities developed by the child from his earliest years (recognition of visually and auditorily perceived forms, development of spatial and temporal organizing capacities through a diversity of activities, such as constructing games, singing, dancing, etc.). Some authors even talk of games *without any relationship* to reading itself (Alegria & Morais, 1979). As can be see, the notion of prerequisites is very imprecise. It can be understood in its narrow sense or, at the other extreme, in a very broad sense, where recursively it may include the quasi-totality of the child's previous acquisitions.

The same applies to alphabetic writing, the teaching of which *in the strict sense* generally begins at about the same age but is preceded by a whole series of activities—especially graphic activities—which the child has been practicing for several years and which may be considered an integral part of learning to write *in the broad sense.* Some French researchers (Auzias, Casati, Cellier, Delaye, & Verleure, 1977) who wrote the book *Writing at Five Years?* came to the following conclusions:

> We can envisage an intitiation to writing at *around six years of age.* In fact, it is only at age 5;9 that the majority of children in the first grade manage to copy legibly and with relative ease—even those who are given daily practice in copying a short phrase. As a result, it is *pointless, even deleterious,* not to respect the *normal rhythm* of child development. . . . On the other hand, exercises *in preparation* for writing seem to us to be *indispensible* in this first grade. By this we mean all those language activities, or rather those occasions for language, all the motor and graphic activities (e.g., painting,

> drawing, picture stories, etc.) which prepare the child for story telling, for symbolic representation, for handling instruments and which apply his eye and hand to the creation of forms. (pp. 40, 131)

Nevertheless, Auzias et al. (1977) do not think it would be very useful to "systematically initiate the first-grade child in "pictographics" even in simplified form, to familiarize him with conventional (figurative) transition signs for translating language. Our writing system is not ideographic but phonographic, using alphabetic representation; the signs in this system (letters) have absolutely no direct symbolic value expressed by their form" (p. 164).

Prerequisites for Learning to Read

As far as reading is concerned, the question of prerequisites or readiness to learn was reformulated in an interesting way by Liberman and his colleagues. (Liberman, Shankweiler, Fischer, & Carter, 1974; Shankweiler & Liberman, 1976; Liberman, Shankweiler, Liberman, Fowler, & Fischer, 1977) and was taken up again and developed by Alegria and Morais (1979). At the beginning of their article, Alegria and Morais review the principal causes which have been implicated in reading difficulties: letter perception, the perception of sounds, and letter-sound association. According to these authors, reading difficulties are not automatically associated with the defective functioning of one or more of these abilities. They point to a number of studies which show that children with reading difficulties do not have difficulties in perceiving letters and sounds any more than in audiovisual integration (grapho–acoustic association) or spatiotemporal association. These capacities certainly constitute prerequisites for learning to read—in the broad sense they are necessary conditions; in the same way, a certain level of mastery of spoken language is a prior condition. But these prerequisites are all satisfied in the 6-year-old child, including those who present difficulties in learning to read.

On the other hand, according to these authors, learning to read within an alphabet system does presuppose the *capacity for explicit analysis (or segmentation) of speech in terms of phonemes.* Now this capacity appears in the child at around 6 years of age. It increases rapidly at the onset of reading instruction and seems to be an important *accelerator* of this ability. It is present in a small percentage (17%) of 6-year-olds after three months of primary schooling but reaches a high percentage (70%) by the beginning of the second year of primary school. The question raised by these authors is whether the improvement of this ability is a direct result of a normal process of intellectual maturation or whether it is mainly the result of training in reading. Morais and Alegria provide an answer to this question on the basis of results obtained in a number of studies: One study compared the performance of children of the same age (Mean age of 6;6 years) in tasks involving phoneme segmentation and phoneme fusion after 3 or 6 months of primary schooling. After 3 months of primary school, they obtained scores of 17% of successful phoneme segmentation and 29% of successful phoneme fusion; after 6 months, they obtained scores of 37% and 57%, respectively, for each of these tasks. The authors

therefore conclude that instruction in reading or schooling has a *net accelerator effect* on the capacity for phonemic segmentation. A second study concerning phonemic segmentation ability in illiterate and literate Portuguese adults (Morais, Cary, Alegria, & Bertelson, 1979) shows that the performance of adult illiterates is similar to that of Belgian children in the first year of primary school (6;6 years), following 3 months of schooling. The performance of the literate adults was equivalent to that of children starting their second year of primary schooling.

The first conclusion which Alegria and Morais (1979) draw from these studies I find a little disconcerting: "Simple (intellectual) maturation does not lead man to an awareness of the existence of phonetic units in speech" (p. 265). I must admit that I do not understand how intellectual maturation, in the absence of specific exercises, could ever lead to these units. The second conclusion is that conscious analysis of speech on a phonetic level is not a prerequisite for learning to read, meaning by prerequisite, "a necessary and preliminary competence." On the other hand, they evoke an *underlying or potential* capacity which would be *necessary* for the phonetic analysis of speech, but which would require confrontation with a problem demanding this analysis—such as reading—in order to emerge. This would be a good example of what I would be inclined to call a *prerequisite in the strict sense*. The authors finally point out that we do not know what the (intellectual) maturation process for this potential capacity may be, a capacity which could, according to them, be present well before 6 years.

At this point two essential questions arise: What is this underlying capacity not defined by Alegria and Morais? Is this underlying capacity present before 6 years? I am going to use these questions as a basis for formulating some hypotheses which will then serve as a guiding thread for the remainder of my discussion:

1. This underlying capacity is a *general capacity for segmenting a whole into abstract units*.
2. This capacity is the corollary of *the general capacity for integrating elements into a whole* whose meaning and properties are not reducible to the sum of the properties of its constituent elements. In fact, in order to be able to divide a whole into parts, one must be able to define it and to compose it.
3. The units resulting from segmentation are not of the same nature and do not have the same status as the constituent elements of the whole.
4. The general capacities for segmentation and integration are not constructed in the way Piaget conceived them to be but are brought into play at different stages in development, for example, at around 6 years of age with respect to the conceptual elaboration of behaviors (2 to 10 years), around age 6 months for the "perceptual" elaboration of behaviors (0 to 2 years) and around 14 years for the "semiotic" elaboration of behaviors (see previous discussion).
5. These capacities only appear in relation to the realities with which the child has been confronted in the years or months preceding their implementation (and only if the situations or tasks proposed or encountered demand it).

As a function of these hypotheses, I will first try to show that the capacity

underlying the *phonemic segmentation of a word* is this general capacity for segmenting a whole into abstract units, which would not appear until around age 6 years. Next, I will examine several kinds of segmentation, emphasizing the particular nature of the one appearing at 6 years. Then I will analyze the different kinds of sentence *segmentation*, once again trying to show the radical change produced at around 6 years. In this way, I hope to show that the prerequisite revealed with respect to learning to read is not specific to this particular behavior, but also intervenes at the same age in other areas such as sentence comprehension. Then, still generalizing, I will try to show that this same underlying capacity for segmenting a whole, and its corollary, the capacity for integrating elements into a whole, also constitutes prerequisites allowing the child to define simple physical tools as homogeneous wholes and not as sets of juxtaposed elements.

This approach aims to demonstrate the steps in the acquisition of a new behavior (reading, sentence comprehension) and to show that these steps are determined by important and general qualitative changes in the organisation of the child's behaviors.

Having demonstrated the existence of steps (phases or levels) in the acquisition of new behaviors principally related to new processing capacities becoming functional at certain ages, we will mention briefly and finally how the appearance of new coding capacities (at birth, at 2 years, and at 10 years) determines the existence of the major general stages.

Regarding the Capacities for Segmentation

Word Segmentation

The purpose of the previous examination of the problems of prerequisites for learning to read allowed us to take a more general look at segmentation or the analysis of activities as prerequisites to a reading activity. Activities of segmenting or fractioning speech are carried out by children younger than 6 years, especially syllabic segmentation which is achieved by 46% of 4-year-olds (4;10) (Liberman et al., 1974). Therefore, we are not dealing with a general impossibility for children under 6 years to fragment or decompose an auditorily (or visually) perceived continuum from a temporal (or spatial) point of view. These capacities for syllabic segmentation would explain why Japanese children learn, without systematic instruction, to read the *katakana* before entering school (Sakamoto & Makita, 1973). It would also explain how Rozin and Gleitman (1977) managed to teach children who experienced difficulties with the alphabet to read syllabic writing without any notable effects on their capacity to read with the alphabetic system.

Syllabic segmentation seems to me to be possible, because it is based upon units (elements or segments) which can have a reality of their own and may sometimes have their own meanings for the child, independent of the totalities into which they may be placed. In contrast, phonemic segmentation is based on *units,* which have been described as *abstract* or *formal* and which have no existence or meaning independent of the whole of which they are a part. They can only result from

breaking this totality into parts and have no existence outside these totalities. Expressed differently, the phoneme would only exist as a *part* of a whole and would not be accessible to 3-, 4-, or 5-year-olds, whereas the syllable could exist on its own, independent of any larger entity which might include it as a segment. This does not mean, however, that the syllable has the same signification or status when it is identified as an isolated entity as compared to when it is a part of a whole. These distinctions are, of course, only relative and correspond to what may be considered the subject's point of view at different steps in development. Liberman has shown that children can break words into syllables from the age of 4, while a more recent study by Bellefroid and Ferreiro (1979) shows that the syllable becomes a *part* of a word (with a defined position with respect to other parts) from the age of 6 years (amazing coincidence!). As a part of a word, the syllable no longer has its own meaning and is thus *defined with respect to the ensemble of word parts,* in particular, by its relative position. Thus, during development, the syllable can have two fundamentally different statuses: (a) before 6 years it would have the status of *independent unit* (inseparable from meaning) which may be regrouped or juxtaposed with other syllables; (b) after 6 years it would have the status of *part of a word,* but essentially defined in terms of its relative position.

We have shown that segmenting activities were performed by children under 6 years, but that segmentations performed before and after 6 years did not have the same status. From this point of view, it seems possible to consider the capacity for segmenting a whole into abstract units as the major prerequisite for learning to read in the strict sense.

Sentence Segmentation

In another branch of psycholinguistics concerned with the comprehension of sentences (or phrases) (cf. Bronckart, Kail, & Noizet, 1983, for a review), different strategies have been revealed for segmentation or fractioning. These strategies for segmenting sentences are based on different indices: semantics, positionals, and formals (morphosyntactics). The passage from pragmatic strategies (based on the semantic characteristics of lexemes or on their proximity) to formal strategies (based on the relative positions of lexemes or on morphosyntax as well as semantic characteristics) also takes place around 6 years of age, with, of course, important variations depending on the kinds of expressions used (Sinclair & Ferreiro, 1970).

Now the question is to know what it is that distinguishes these different varieties of segmentation or these different levels of analysis of words and phrases (syllabic and phonemic; pragmatic and formal) and, above all, whether they are specific to language. Is it possible that clearly distinct capacities exist for segmentation and composition before and after the age of 6? If so, to what competencies would they belong? As far as phonemes are concerned, we should point out that Gleitman and Rozin (1977) consider the segmentation of speech into phonemes as being extremely abstract. These segments would only be very indirectly represented in the sound wave. In contrast, syllabic segmentation could be described as more concrete. Thus we would have a passage from concrete to abstract segmentations, or

Table 1. Different Varieties of Segmentation of Words and Sentences.

Elaboration of the Word or Verbal Sign		
Syllabic segmentation ("concrete"): The syllable is defined by its semantic characteristics	or	Syllabic pseudo-segmentation: The syllable is an independent unit which may be found in relationships of proximity with other syllables
6 Years		
Phonemic segmentation ("abstract"): Phones are defined by their relative positions in the acoustic wave	or	True syllabic segmentation: The syllable is a part of the word it is defined by its relationships with the ensemble of constituent parts of the word

Elaboration of the Sentence
Pragmatic segmentation: Based on the semantic characteristics of lexemes or on their spatial proximity
6 Years
Formal segmentation: Based on the relative positions of lexemes or on morphosyntax

from pragmatic to formal. These qualifiers have a familiar ring for developmental psychologists, although they are usually used to distinguish distinct stages, whereas here they characterize periods or steps within a stage.

I think that these two categories of segmentation are radically different, as I have already suggested, and that they depend on important qualitative changes at the level of cognitive instruments or cognitive capacities. For me, these changes would not occur before 6 years of age as far as the developmental stage between 2 and 10 years is concerned. They would depend on a process of maturation of the neural system that is relatively insensitive to environmental influences.

For certain psychologists (Boutet, Gauthier, & Saint-Pierre, 1983) this transition characterizes the passage from linguistic activities to metalinguistic activities defined as "the *capacity to consider language as an object* upon which logical operations may be performed, such as segmentation, grouping, and serial positioning" (Bellefroid & Ferreiro, 1979, p. 33).

In Karmiloff-Smith's (1979*a* and *b*) studies on determinants in language acquisition, this cutoff at 6 years would correspond to the passage from surface markers to an organization based on deep structures (formal procedures capable of fulfilling different functions).

Using examples borrowed from psycholinguistics, I have tried to show how, after 6 years of age, new means for segmenting words or sentences can be explained by a general capacity for segmenting a whole into abstract units being brought into play. I would now like briefly to show how this segmenting capacity manifests itself in relation to the way the child is able to define simple objects, such as tools, in problem-solving situations. This example will also allow us to demonstrate the capacity for integrating elements into a whole (the corollary of the former). Finally,

we will mention two other research areas where the age of 6 years is also typical of a change in organization comparable to those we have defined.

The Construction of Tools: Two Levels of Analysis

Regarding this passage from a pragmatic or concrete organization to one which is formal or abstract, occurring at around six years, I would like briefly to summarize the results of some research carried out on the construction of simple tools by 4- to 8-year-old children (Mounoud, 1970). In these studies I demonstrated two levels of analysis and resolution of problem situations which were radically different. These two levels seem to me to bear a close correspondence to the two levels of organization I just discussed regarding the comprehension of words and sentences.

A *primary level* of analyzing problem situations and of defining tools, typical of 4- and 5-year-old children, is based on a decomposition of the problem into tasks or elementary actions/properties: for example, in tasks involving reaching, reaching around, pushing, and seizing. These actions are used to define or qualify different segments or pieces of a tool. Each segment thus has its own property (or constituting function): reaching, reaching around, pushing, taking, grasping, hooking, etc. This kind of segmentation could easily be called pragmatic or semantic as have the first strategies for understanding phrases (or sentences), also typical of 4- and 5-year-olds.

At the *second level,* tools are defined by a general function or by global transformation progressively specified by the relationships between different parts of the tool and of the situation. These parts only have meaning in relation to the whole, and these relationships are referenced to a signification for the entire tool. An example of one of these tools would be one designed to move a wood block while avoiding obstacles or to remove a block with a hook on it from a jar. The defining properties of the tools are at the level of relationships such as spacing, length, inclination, or curvature of different constituent parts. *These parts are no longer defined in isolation by means of specific properties, but, rather, they are defined by their mutual relationships.* Such a conception could perfectly well be described as morphological, formal, or abstract, and could therefore correspond to the formal or abstract capacities for analyzing and segmenting words and phrases. The second level is also characteristic 7- and 8-year-old children.

Segmentation or composition of tools is possible at both levels, but they are completely different in nature. It is as if, for the 4- and 5-year-old children, *the tool is gradually defined by juxtaposition of segments or pieces,* each one having a defined property or direct relationship with the child's different actions (pragmatico-semantic aspect). This is reminiscent of the figural collections defined by Inhelder and Piaget (1959) in the realm of classifications. In contrast, at the second level for 7- and 8-year-olds, the tool is defined by a global transformation relative to certain constraints and conditions inherent in the situations. *The tool is defined as a whole composed of parts* (which only have meanings with respect to the whole) for which only the structural relationships between parts give it its function.

The features of the tool, of the situation, and of the actions taken into consideration by 4- and 5-year-olds or 7- and 8-year-olds do not have the same status, despite how they might appear or, especially, despite our adult observer's point of view. Both cases might deal with "length," for example, but what the 4- and 5-year-old calls long or short will not have the same meaning as that for the 7- and 8-year-old. In the first case, with 4- and 5-year-olds, we would be in the presence of what Piaget called preconcepts, where the object and what it signifies are not clearly dissociated. For these children objects or instruments are characterized by isolated properties which may be juxtaposed to make up what we might call "amalgams," in reference to the notion of "amalgamated predicate" defined by Wermus (1976, 1977). Object properties are directly dependent on the meaning of actions performed on them or for which they substitute. Objects represent or stand for actions. They are a kind of transposition of them, an analogue translation, a *substitute*. Their definition will depend on the presence or absence of this or that segment to which a particular meaning is attached and where the whole is not taken into account.

With 7- and 8-year-old children, the instruments become the *support* for meanings attributed to the whole, which are no longer relative to such and such particular actions but to one or several transformation(s) of the whole. The instruments are no longer defined by the presence or absence of this or that isolated characteristic but uniquely by the relationships between their different parts.

Once again the age of 6 years constitutes the transition between these two levels of organization. It is at around 6 years that the integration of previously isolated and juxtaposed properties takes place, which eventually give rise to wholistic meanings enabling transformations to be considered. I noticed that when the children succeeded in defining an instrument by means of a holistic property, they momentarily no longer succeeded in constructing or modifying an instrument. They were only satisfied by the discovery of an instrument which had the whole set of anticipated characteristics.

Before 6 years it would be possible to say that objects do not exist "conceptually" for the subject as wholes. Their sole conceptual existence would be linked to the current or previous actions associated with them and for which they act as a kind of extension or substitute. The objects would only have partial, local and momentary "conceptual" identity. We will not discuss here the different forms of perceptual identity.

From (about) the age of 6, objects become identifiable in a stable and global way, and they have acquired a global qualitative identity (to use Piagetian terminology) without the relationships between parts of the object or between different objects yet having been mastered. Their identity no longer depends upon current contingencies of the action. In other words, the objects become permanent. This permanence, in terms of conceptual elaboration, is still limited by the degree of organization of the relationships the child is capable of mastering, both between the constituent parts of the object and between different objects.

It is noteworthy that we have found this critical age of 6 years in our research on the development of the self-image in the child from 3 to 11 years of age (Mounoud

& Vinter, 1981b, in press). This research studied the precision and stability of the child's image of his or her own face using a distorting mirror. In particular, we are studying the way in which children are affected by their initial confrontations with distortions of their face. Our findings were that, at age 6, children had a precise and faithful representation of themselves.

Similarly, in our research on the planning and control of movements, the study of visuo-manual tracking of periodic signals in 3- to 9-year-old children (Mounoud, 1982; Mounoud, Hauert, Mayer, Gachoud, Guyon, & Gottret 1983; Mounoud, Viviani, Hauert, & Guyon, in press) the age of 6 years marks the passage from *local control* to *global control* of movement, which we interpret as the child's capacity for anticipating the to-and-fro' movements of the target and their arm movements as a totality and not locally, step by step, in a way which then permits the resolution of the problem of coincidence between target movements and their own movements.

From the outset of this text I have tried progressively, using different contents (word, phrase, instrument, face, movement) to define the articulation between two levels of behavioral organization or object elaboration, that is, two qualitatively distinct levels of organization of exchange between subject and environment. These two levels would characterize an *invariant developmental sequence* which defines the internal dynamics of each stage. In this way the principal articulation in the elaboration of new behaviors within each stage would be determined fundamentally by general segmenting and integrating capacities becoming functional. The changes that occur are changes in *processing capacities*.

Our analysis so far fits into a general conception of the psychological development of child behavior which should be outlined briefly before concluding. Within this conception, stages are defined by changes in *coding capacities*, whereas changes in processing capacities determine the steps, levels, or revolutions within each major stage.

Model for the Construction of Representations

The construction of "new" structures is performed, according to Piaget, by the process of reflective abstraction or convergent reconstruction with overtaking. This process brings about the construction of structures which might be qualified as formal, in the sense that they are more or less independent of the contents of the objects to which they are applied.

As I have already written elsewhere (Mounoud, 1979/1981), Piaget's psychogenetic theory regarding the construction of structures appears to me to be extremely vulnerable to criticism. From my point of view, what the child constructs are not structures but *representations or internal organizations of contents*. The child arrives at them by means of structures, which I feel are more economically considered as preformed. Now it is possible to reinterpret the process of reflective abstraction as a *process of construction of representations* and no longer as a process of construction of logical structures (internalization of general coordinations of action). This is what I have been trying to do in my analysis of the child's

construction of simple tools (Mounoud, 1970) and which I have progressively generalized and transposed to the sensorimotor period (Mounoud, 1971, 1973, 1976/1982, 1983).

Piaget distinguished two phases or types of reflection in the process of reflective abstraction, which are repeated at each developmental stage, giving rise to new structures. The first is a primary reflection in the physical sense of the term, consisting of transposing the elements (action schemata or operations) of the previous structure onto another plane. The second reflection is in the psychological or mental sense, and it consists of a "*reshaping through thought* of previous material presented in its raw or immediate state" (Piaget, 1967, p. 366).

Within the perspective I have been developing over several years, these two phases consist of the translation, by means of a new code, of the different contents with which the child interacts (with objects, people, or his own body). It is necessary to distinguish several types of codes giving rise to representations on different levels. These can be found in Table 2.

It is the appearance of new coding capacities, which I have suggested calling perceptual at birth, conceptual around 2 years, and semiotic or formal around 10 years, which determine the stages of cognitive development of the child. These new coding capacities constrain the child to reorganize, to redetermine his behaviors, and not, as Piaget insisted, the achievement or the closing off of a new structure. An early revolution consists of dissociating the properties of actions and of objects

Table 2. Codes and Representations on Different Levels.

Stages	Levels of Representations	Type of Organization
Birth	Sensorial representations (preformed) linked with preformed structures + new coding capacities (the perceptual code) ⇒ Construction of perceptual representations	Sensorimotor Organization (preformed)
18–24 Months	Perceptual representations (constructed) + new coding capacities (the conceptual code) ⇒ Construction of conceptual representations	Perceptivomotor Organization (constructed)
9–11 Years	Conceptual representations (constructed) + new coding capacities (the semiotic code) ⇒ Construction of semiotic representations	Conceptuomotor Organization (constructed)
16–18 Years	Semiotic representations (constructed)	Semioticomotor Organization (constructed)

(represented in the previous organization) in order to constitute new elementary representations. The principal characteristics of these new representations are that they are partial, local, and juxtaposed. They would also be of the analogous type. This first revolution would correspond to the first physical type of reflection described by Piaget). The reorganization comes to an end with the integration of these elementary representations into *new or global representations* which are momentarily rigid and nondecomposable, nonsegmentable. The second revolution consists precisely in the decomposition of these total representations into parts or units in such a way as to establish relationships between their components. It is not necessary to explain the correspondence between these two revolutions and the two levels of functioning or elaboration of objects described in the first part of this text.

Illustration of the Model in the Stage of Perceptuomotor Organization

It is possible to demonstrate this developmental sequence during the first two years of life. A transition comparable to that defined around age 6 occurs at around 6 to 9 months. It is at this moment that children are capable of defining objects in a singular or individualized way on the basis of the collection of properties accessible to them.

Let us briefly describe this sequence using data concerning knowledge manifested by the baby regarding his body, in particular, his arms and his hands. This analysis will draw mainly on the example of reaching for objects. It is precisely around 24 to 32 weeks that the baby is capable of correct organization of his arm and hand movements in order to seize objects within his reach. The movement is usually described as visually triggered or "ballistic," i.e., programmed before its execution, the hand opening during the course of the trajectory, closing again on the object. Before and after this age, it seems possible to distinguish two levels of organization comparable to those defined earlier.

Before 24 weeks or, more precisely, between 2 and 5 months, infants present a whole series of behaviors showing the way in which they are progressively discovering the different properties of their hands and arms. Hand opening and closing, wrist rotation, extension, and flexion of the elbow, reciprocal grasping of the two hands, etc. Through these different behaviors the baby discovers and progressively controls the properties of different arm segments and will eventually be able to order these movements sequentially to carry out the complex act of reaching. This brings us to the 24-to-32-week level which White, Castle, and Held (1964) considered the "top level" of reaching.

After 32 weeks, this nondecomposable, nonmodulable collective activity constituting reaching gives rise to an extremely complex reorganization which consists of controlling the different parts or units of this complex activity to adapt to the different conditions under which the activity is supposed to be able to be used. This second level, which could be qualified as late evolution, has been remarkably described by Halverson (1931). We could also consider that some situations de-

Table 3. Elaboration of New Representations.

Stage 1	Stage 2	Stage 3	Steps	Process
0–1 month	1½–3 years	10–11 years	Initial global representations: Syncretic	
				Sampling of object and action properties: By means of new code
1–4 months	3–5 years	11–13 years	New elementary representations: Separated and juxtaposed	
				Coordination–integration of elementary representations: And establishment of correspondence with objects and situations
4–8 months	5–7 years	13–15 years	New total representations nondecomposable: Rigid with global relationship between them	
				Decomposition–analysis of new total representations in their components: And establishment of correspondence with objects dimensions
8–14 months	7–9 years	15–16 years	New total representations partly decomposable: With partial relationship between them and their components	
				Composition–synthesis of the components of new total representations
14–18 months	9–10 years	16–18 years	New complete representations fully decomposable: With complete relationship between them and with their components	

signed to study the development of object permanence, such as reaching for an object hidden behind a screen or a detour situation, equally characterize this late evolution (Bruner, 1970; Lockman, 1980). Adaptations to the reach as a function of different orientations of the object to be seized, studied by Ashmead, Lockman, and

Bushnell (1980; Lockman & Ashmead, 1982), as well as adaptations tc the grasp as a function of the weights of objects which I have studied in the past (Mounoud, 1973; Mounoud & Bower, 1974) are other examples of the second level of organization beginning around 6 to 8 months and ending at around 16 months.

I would have liked to demonstrate in greater detail the existence of this "developmental sequence" at this period of development. This has been done in two recent articles (Mounoud, 1983; Mounoud & Vinter, 1981a).

In order to get a better understanding of the significance of this sequence, it is necessary to take into consideration the behaviors manifested by the baby during the first weeks of life. Several authors (Bower, Broughton, & Moore, 1970*a* and *b*; Trevarthen, Hubley, & Sheeran, 1975; von Hofsten, 1982) have demonstrated that the children are, during the first days of life, capable of a kind of reaching which is quite surprising: They are able to project an arm in the direction of a visually perceived moving object. The newborn's reaching behaviors manifest a processing of certain categories of information related to the situation, his or her actions, and the objects. These data clearly show (if it was necessary to do so!) that there exist different levels of organization and control of the child's behavior. The passage from one organization to another, or what amounts to the same thing, the construction of a new organization of behaviors (i.e., interactions or exchanges between the subject and his environment) defines a stage. The developmental sequence which I have tried to set out defines, in gross terms, the fundamental steps in these successive reorganizations.

Conclusion

The conception presented here is in favor of describing developmental stages that are common to all areas of knowledge. I am aware that this point of view goes against some current conceptions which reject the idea of unified stage encompassing all areas of knowledge (cf. especially Bates, 1979). This conception ascribes a more important role to the process of neural maturation and the biological substrates of behavior which determine the origin of the steps in this developmental sequence. The maturation of the neural system itself depends on the nature of the interactions of the organism with the environment but in a nonspecific way these interactions at the most being able to accelerate or slow down the process. On the other hand, the environment plays a specific role in cognitive development in relation to the contents of experience and the exchanges of subjects with their environment, and more precisely, the realities with which they have been confronted. These experiences will directly determine the contents of the representations elaborated.

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